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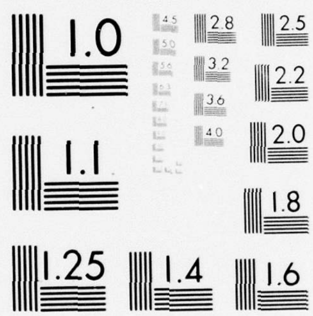
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STUDY REPORT
CAA-SR-77-10
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COST EFFECTIVENESS ANALYSIS OF BONUSES AND REENLISTMENT POLICIES

(CEABREP)

AUGUST 1977

PREPARED BY

METHODOLOGY, RESOURCES AND COMPUTATION DIRECTORATE

US ARMY CONCEPTS ANALYSIS AGENCY
8120 WOODMONT AVENUE
BETHESDA, MARYLAND 20014

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Bonus, Reenlistment, Continuation Rates, Demographic Characteristics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

To manage the bonus program effectively, the Army must first accurately predict personnel imbalances by Military Occupational Specialty (MOS) and then estimate the bonus level and/or policy decisions which would be necessary to alleviate potential disparities. The CEABREP study addresses both the force projection process and the factors influencing reenlistment behavior. The report consists of six chapters supported by technical appendices. Chapter 1 provides introductory material and background. The methodology formulated to analyze the reenlistment environment is the subject of Chapter 2. MOS-unique continuation rates

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20. (continued) (for p 1473A)

which were developed to improve the accuracy of force projections are discussed in Chapter 3. An analysis of retention factors is in Chapter 4 and alternatives to bonuses are identified in Chapter 5. The final chapter of this report presents the major observations.

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COST EFFECTIVENESS ANALYSIS OF BONUSES AND REENLISTMENT POLICIES
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AUGUST 1977

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8120 WOODMONT AVENUE
BETHESDA, MARYLAND 20014

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DEPARTMENT OF THE ARMY
US ARMY CONCEPTS ANALYSIS AGENCY
8120 WOODMONT AVENUE
BETHESDA, MARYLAND 20014

REPLY TO ATTENTION OF:

8 August 1977

MOCA-MRR

SUBJECT: Cost Effectiveness Analysis of Bonuses and Reenlistment Policies

Assistant Secretary of the Army
(Manpower and Reserve Affairs)
Washington, DC 20310

1. Reference: Letter, Office of the Assistant Secretary of the Army, dated 13 Oct 76, subject as above.

2. In accordance with the referenced directive letter, the US Army Concepts Analysis Agency (CAA) has conducted a study and related system design effort to assist in evaluating the potential costs and effectiveness of alternative reenlistment bonuses and policies. This work has resulted in a quantitative methodology for application in management of enlisted personnel. The attached study report presents the methodology, detailed system design specifications and additional information necessary for full implementation. This report also provides insights and observations on the reenlistment behavior of FY 71 accessions and discusses alternatives to high bonus payments.

3. A substantial portion of the CEABREP methodology has been embodied and tested in a set of computer-based programs resulting in immediate benefits to personnel managers.

a. The MOS-unique continuation rates developed for the CEABREP system have been provided to MILPERCEN; these rates will improve the accuracy of force projections at the MOS/Grade/Years of Service level of detail.

b. The methodology for estimating the reenlistment behavior of first-term soldiers based on a multi-dimensional demographic view provides an immediate and solid approach for improving personnel forecasts, focusing personnel policies, and estimating the effects of personnel policies.

MOCA-MRR
SUBJECT: Cost Effectiveness Analysis of Bonuses and Reenlistment Policies

4. Pending the availability of data required for full operation, the CEABREP System will provide the Army with a versatile analytical tool to assess present and future retention programs. This development offers a substantive opportunity to improve the Army's capability to analyze and direct incentive programs for enlisted manpower management.

1 Incl
as

JOHN T. NEWMAN
Technical Director

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

13 OCT 1976

SUBJECT: Cost Effectiveness Analysis of Bonuses and Reenlistment Policies Study

THRU: Director of the ~~Army Staff~~ WBF 15 OCT 1976
Department ~~of the~~ Army
~~Washington~~, D.C. 20310

Deputy Chief of Staff for ~~Operations~~
and Plans
Department ~~of the~~ Army
~~Washington~~, D.C. 20310
AEBG
20 Oct 76

TO: Commander
US Army Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, Maryland 20014

1. Purpose: This Category 1 (Manpower and Personnel) study will be performed to develop an automated system that will enable managers to assess the potential costs and effectiveness of bonuses and bonus policies as management tools to attract and retain enlisted personnel. This tasking directive supersedes reference 2a below.

2. References:

a. Letter, Office of the Assistant Secretary of the Army, dated 23 Apr 76, subject: Bonus Management Study.

b. Program Objective Memorandum FY 77-81.

c. Personnel Inventory Analysis/Years of Service/Objective Force Model (PIA/YOS/OFM) System Documentation.

d. Concepts Analysis Agency Study Report CAA-SR-74-19, Vol 1, "The Enlistment Bonus."

e. General Research Corporation Study Report, "The Effect of the Combat Army Enlistment Bonuses on Army High School Graduate Accessions," Feb 76.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

SUBJECT: Cost Effectiveness Analysis of Bonuses and Reenlistment Policies Study

3. Study Sponsor: Office of the Assistant Secretary of the Army (M&RA).

4. Study Agency: US Army Concepts Analysis Agency (USACAA).

5. Terms of Reference:

a. Background. The Army has historically used bonuses to attract enlisted personnel in military occupational specialties (MOS) that are perceived by the potential enlistee to be hazardous or unattractive. Bonuses have also been used to retain enlisted personnel who have developed Army skills that are closely correlated with better paid civilian jobs. Because of funding constraints and continuing Congressional challenge, it is vital that the Army use bonus dollars in the most effective manner and be able to present a sound and comprehensive case to demonstrate that effectiveness. This Category 1 cost effectiveness study will provide insights on bonus management as well as bonus effectiveness.

b. Problem. Enlistment bonuses, when expanded to include MOS other than Combat Arms and used in conjunction with the reenlistment bonus, present the Army with an increased capability to influence accessions and retentions. To manage the bonus program effectively, the Army needs the capability to predict the results of bonus and policy decisions on reenlistment by MOS and the ability to evaluate the cost effectiveness of potential courses of action designed to alleviate projected shortfalls.

c. Objectives.

(1) To develop and transfer to the US Army Military Personnel Center (MILPERCEN) an automated system that will: (a) predict the effects of the selective reenlistment bonus (SRB) and reenlistment policy decisions on reenlistment rates for individual MOS. (b) permit Army personnel managers to estimate the cost and assess the effectiveness over time of bonus programs or policies designed to alleviate MOS shortfalls.

(2) To explore alternatives to high selective reenlistment bonus payments such as restoration of the CONUS to CONUS station-of-choice reenlistment option.

d. Scope. The study will encompass the following areas:

(1) Bonuses offered to induce reenlistments.

(2) The potential effects of the enlistment bonus on reenlistments.

(3) Possible alternatives to high SRB levels.

(4) MOS-unique continuation rates.

SUBJECT: Cost Effectiveness Analysis of Bonuses and Reenlistment Policies Study

e. Limits.

(1) This study will be limited to analysis of those MOS authorized a bonus and a representative set of plausible bonus policies as determined by the sponsor. Sensitivity testing will be performed on the assumptions and key parameters.

(2) Models to be developed will be operational on the CAA computer and CAA will provide system documentation and assistance to aid in transferring those models to MILPERCEN.

(3) Analysis of SRB elasticities will be confined to Zone A bonuses.

f. Time Frame. 1976/1977.

g. Assumptions. See Inclosure 1.

h. Essential Elements of Analysis.

(1) What are the factors influencing reenlistment? Can this influence be quantified?

(2) Does the enlistment bonus, when used in conjunction with SRB, become a lower cost method of providing fill to an MOS? If so, what SRB level?

(3) Are there other cost alternatives that could be used in lieu of or in conjunction with the SRB to provide fill to MOS?

i. Models.

(1) PIA/YOS/OFM (see reference c).

(2) Automatic interaction Detector (AID).

(3) Others to be developed.

6. Support and Resource Requirements.

a. ODCSPER will provide MOS and personnel information as requested by the study agency.

b. OCOA will provide military personnel cost data as requested by the study agency.

c. MILPERCEN will provide computer support and a POC for model transfer as requested by the study agency.

SUBJECT: Cost Effectiveness Analysis of Bonuses and Reenlistment Policies Study

7. Administration.

a. Study Title. Cost effectiveness Analysis of Bonuses & Reenlistment Policies.

b. Study Director. MAJ C. M. Anderson, Methodology and Resources Directorate, USACAA, 295-0390.

c. Study Schedule. See inclosure 2.

(1) IPR/SAG 23 Nov 76, 15 Feb 77, 3 May 77.

(2) Delivery of final report - 8 Jul 77.

d. Control Procedures. The study will be guided by a Study Advisory Group (SAG) in accordance with the provisions of Chapter 3, para 3-4, AR 5-5. The SAG chairman will be appointed by the OASA(M&RA); SAG members will be appointed by the SAG chairman as required.

e. Action Documents.

(1) The automated system will be fully documented and programed to run on computers available at MILPERCEN.

(2) A final report on the study will be prepared.

f. Coordination. This tasking document has been coordinated with CAA IAW AR 10-38.

2 Incl
as

Paul D. Phillips
Deputy Assistant Secretary of the Army
(Manpower and Reserve Affairs

ASSUMPTIONS

1. The demographic characteristics of accessions to an MOS will not change unless the level of the enlistment bonus is changed.

2. If one MOS is added to the list of MOS authorized an enlistment bonus and if the added MOS is similar to MOS previously authorized an enlistment bonus, there will be no net change in the total number of bonus recipients.

3. At a given SRB level, the average SRB payment to a reenlistee is independent of MOS.

4. Continuation rates after the 4th year of service are independent of initial enlistment obligations.

5. The values of exogenous random variables such as unemployment rates that impact on the system will remain relatively stable.

6. The Objective Force Model will provide the desired MOS populations by grade and years of service by which to gauge MOS shortfall.

7. A peacetime environment will continue.

1. Compute MOS-Unique continuation rates.

2. Modify the PIA/YOS Model.

3. Use AID to develop subpopulations and perform regression Analysis.

4. Collect data to support regression analysis.

5. IPR/SAG.

6. Develop base case continuation rates for the first four years of service.

7. Estimate potential effects and costs of programs.

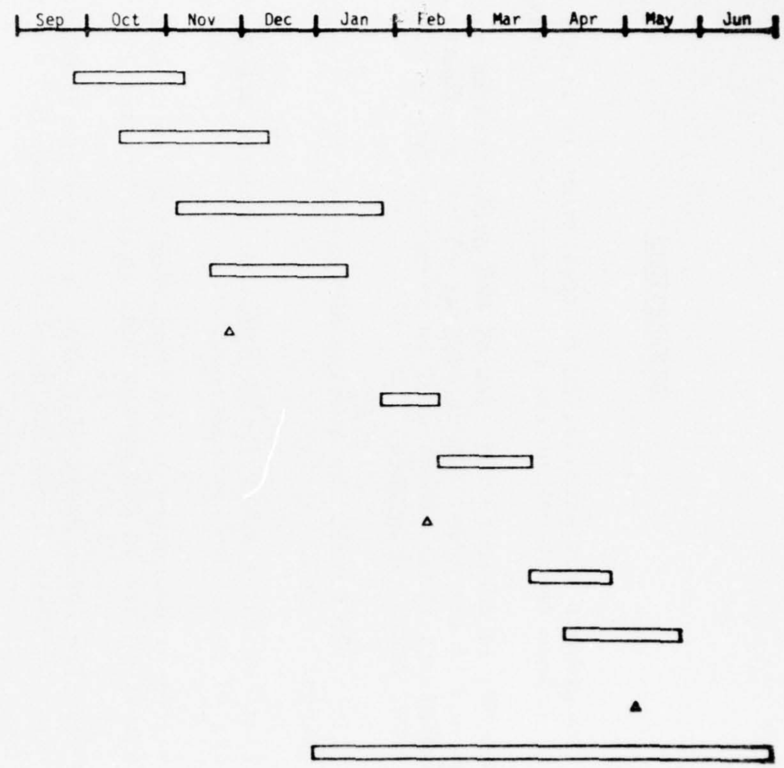
8. IPR/SAG

9. Formulate and evaluate SRB alternatives.

10. Sensitivity testing of key assumptions and parameters.

11. IPR/SAG.

12. Report and model documentation.



SUMMARY

1. BACKGROUND. Technological advances in Army materiel have encouraged the substitution of capital for labor; however, the Army remains a labor intensive force with personnel cost constituting the single greatest expenditure within the Army budget. The trained soldier, therefore, is both the Army's principal "combat system" and its major expense. As such, the trained soldier represents a valuable asset involving considerable investment in resources and specialized capabilities justifying intensive and dynamic programs designed to improve personnel retention.

a. An illustrative program is the reenlistment bonus. The reenlistment bonus is designed specifically to increase the reenlistment rates of soldiers who are in military occupational specialties (MOS) that are understrength because of low retention; low retention may be due to the perceived hazardous nature of the MOS or the perception that the Army is not competitive with the wages provided by the private sector. Limited options exist to change the hazardous realities of certain MOS; however, the reenlistment bonus is a potentially powerful management tool that can be used to compensate for the hazard or to offset the perception of low wages.

b. Because bonuses can be expensive and some soldiers may be motivated to reenlist for other than financial considerations, a continuing effort must be placed on using the bonus effectively and on using incentives which may serve as less expensive but equally effective incentives or surrogates for the bonus. The manner in which to focus bonus programs can be identified by observing the pattern of reenlistment behavior exhibited by the enlisted force. This behavior is sharply divided between two groups: the first-term soldiers and the career soldiers. First-term soldiers are individuals who are serving their initial enlistment, and career soldiers are those who have reenlisted at least once. The reenlistment rate of career soldiers is both higher (nearly double) and more stable than the reenlistment rate of first-term soldiers. It is the transition of first-term soldier to career soldier, or the first reenlistment, which constitutes the critical focal point for the reenlistment bonus or cost effective alternatives to that bonus. Although the general low reenlistment rate of the first-term force is well known, the reasons for it are subtle and complex. Because of the significance and complexity associated with analyzing and controlling first-term retention, people who manage the Army's bonus program (bonus managers) recognized the need for a system to assist in integrating the formulation, analysis and assessment of policies designed to influence retention of the first-term force.

2. PURPOSE AND SCOPE. The Cost Effectiveness Analysis of Bonuses and Reenlistment Policies (CEABREP) Study was initiated at the direction of the Deputy Assistant Secretary of the Army for Manpower and Reserve Affairs [DASA, (M&RA)]. The purpose of this study was to develop an automated system that would assist bonus managers in assessing the costs and effectiveness of reenlistment bonuses and bonus policies. Closely related to this purpose was an objective to explore alternatives to the reenlistment bonus. Because the reenlistment behavior of the first-term force is the critical focal point for application of the reenlistment bonus, the emphasis of this study was on the first term soldier: how to assess his retention behavior more precisely; how to improve it through incentive programs.

3. APPROACH AND IMPACT. The bonus manager, in order to influence the retention of the first-term soldier, must have specific information to focus, formulate, and evaluate his programs. This information is developed from the components of the analytical environment in which the bonus manager operates. Effective management within this environment, depicted in Figure 1, consists of quantitative assessments of:

- Force projections
- Reenlistment behavior
- Alternatives to the reenlistment bonus
- Cost

The components of the bonus management environment formed the framework for the approach to this study and the nucleus of the automated system that was designed to assist the bonus managers. The following discussions summarize how these components were addressed within the study report and integrated into the automated system design.

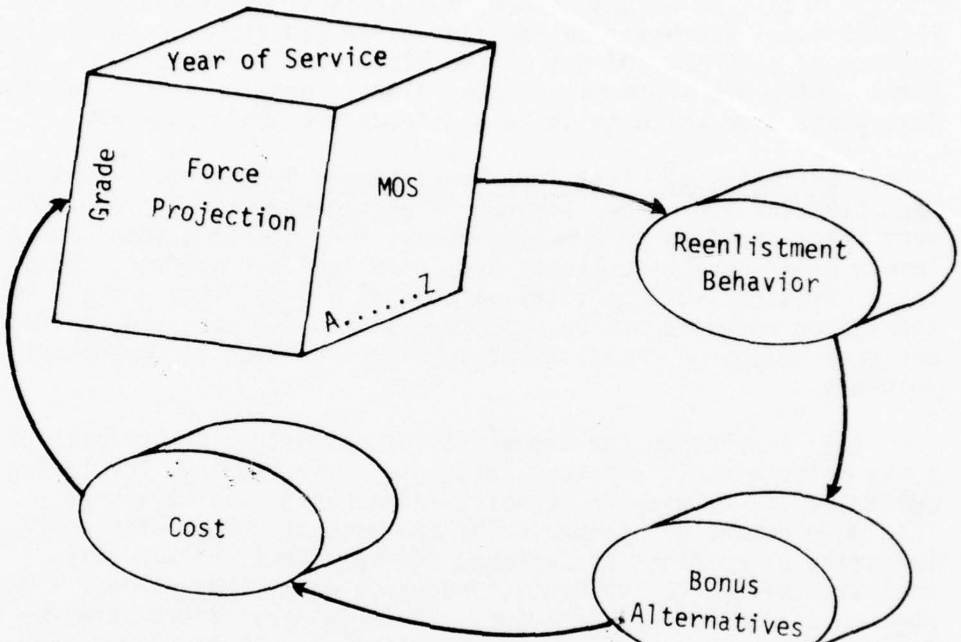


Figure 1. Bonus Management Environment

a. Force Projection. The Army uses a computer-based simulation model to estimate the future personnel composition of the force. This model, the Personnel Inventory/Year of Service (PIA/YOS) Model, projects the current enlisted force from one to four years into the future. These projections are used throughout the manpower management community and, in particular, by bonus managers to identify which MOS are, and/or will be, understrength and to quantify the shortfalls. The PIA/YOS Model, therefore, provides the basis for planning, programing, and allocating resources within the bonus program. As input, the PIA/YOS Model requires continuation rates, i.e., data specifying the likelihood that soldiers in the current force will remain in service for at least one more year. In the past, the complexities of personnel changes from one MOS to another and the addition or deletion of MOS have precluded the development of continuation rates for each MOS level and, consequently, aggregrated rates based on total Army (all MOS) statistics have been used. A significant improvement developed for and incorporated into the CEABREP system design was a methodology to compute MOS-unique continuation rates. This methodology

led to an operational algorithm which has been integrated into the PIA/YOS Model; as a consequence, MOS projections provided by the PIA/YOS Model are based on the aggregated historical continuation pattern of each MOS and not on the historical performance of the Army. These MOS projections, accordingly, provide a more informative basis upon which to shape and focus the bonus program.

b. Estimates of First-Term Reenlistment Potential. Reenlistment behavior expressed in terms of aggregated monthly reenlistment rates provides information useful in estimating total force levels under current policies and bonus levels. However, because these rates reflect the total pattern of all soldiers and all MOS, aggregated rates cannot be used to estimate the effect of policies designed to change reenlistment behavior for specific groups of soldiers.

(1) To provide the capability of estimating the effects of bonus policies on first term retention, a methodology for taking a multidimensional view of reenlistment behavior was developed. This development was supported by analysis of demographic characteristics of soldiers who entered the service in FY 71; this analysis defined 32 subpopulations which exhibited reasonably homogeneous reenlistment behavior. These subpopulations were defined by four variables: race, education, pay grade, and number of dependents (see Table 1).

Table 1. Classes within Variables used to Define Subpopulations

Variable	Classes Within Variable
Race	Black White and other
Pay Grade	E1-E3 E4 and above
Number of Dependents	None One or more
Education	Non-high school graduate High school diploma graduate GED high school graduate Some college education

(2) Figure 2 identifies the subpopulations which have the highest and lowest reenlistment responses within the Black and White subpopulations. Figure 2 also indicates a trend observed in the FY 71 data where the subpopulations within race generally exhibited parallel responses. For example, the General Education Development (GED) high school graduates, with dependents and in grade E4 and above had the highest observed reenlistments rates in both the Black and White racial categories; those with more than a high school education, without dependents and in grades E1-E3 had the lowest reenlistment rates. The generally higher reenlistment rates demonstrated by Black subpopulations does not obviate the fact that certain White subpopulations (e.g., GED high school, with dependents, E4 and above) reenlist at higher rates than certain Black subpopulations (e.g., more than high school, no dependents, E1-E3). Examination of the reenlistment rates demonstrated by the subpopulations provides useful insights on past reenlistment behavior and provides a template with which to estimate the reenlistment behavior of the current force. Quantified estimates of the reenlistment rates by SRB level for the 32 subpopulations of the FY 71 enlistees, are included in Chapter 4.

c. Bonus Alternatives. Because the reenlistment behavior of first term soldiers varies from one subpopulation to another and because funding constraints may limit the size or quantity of bonuses, alternatives to high bonuses are required to provide the manager with increased flexibility. Two cost effective alternatives to the reenlistment bonus are analyzed within this report. These alternatives are: induced reclassification and the CONUS-to-CONUS station of choice option.

(1) Induced Reclassification. Induced reclassification is an option which offers a minimum bonus payment to soldiers in surplus MOS who voluntarily reclassify into shortage MOS. This bonus payment is offered in lieu of increasing the bonus level for soldiers already serving in the shortage MOS. Induced reclassification is designed to redirect the reenlistment potential existing in surplus MOS into shortage MOS. Analysis of this alternative shows this to be a cost effective mechanism for personnel management.

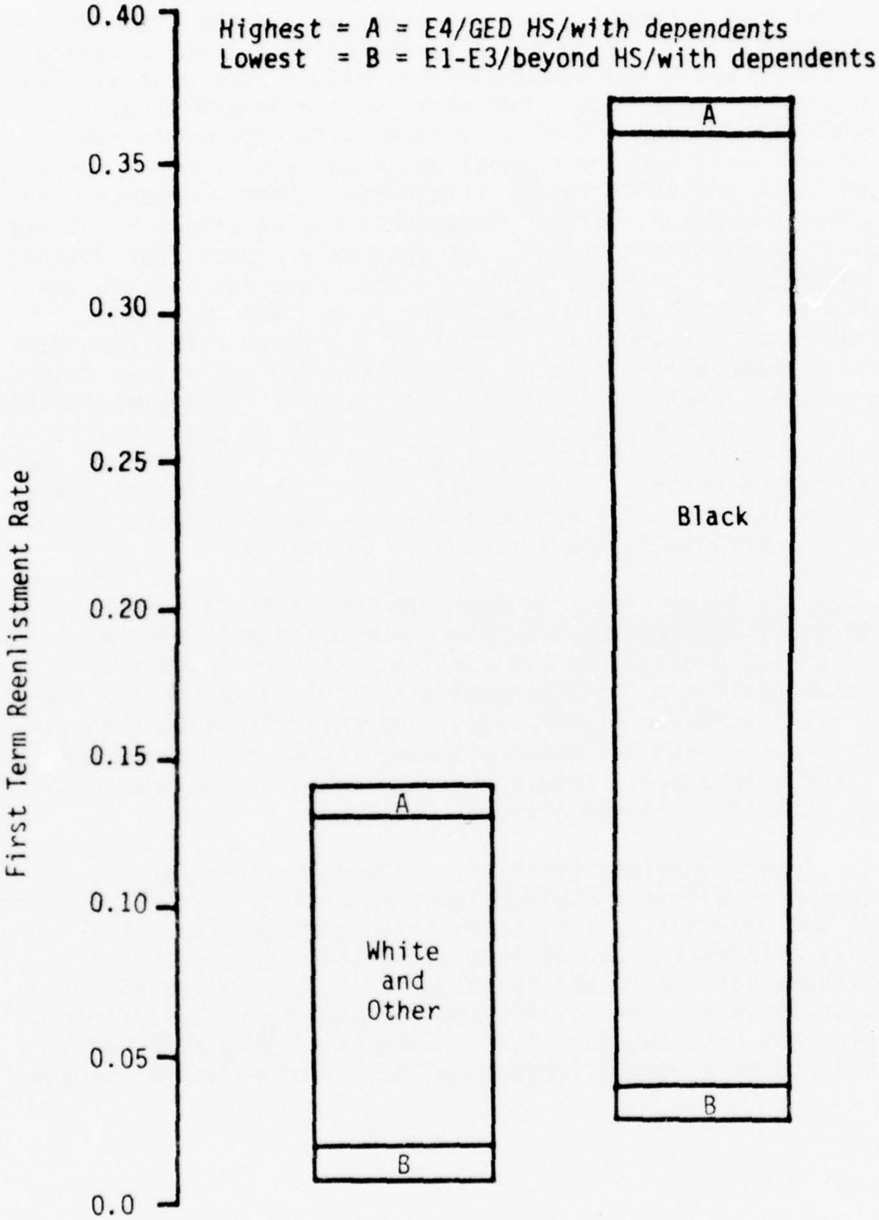


Figure 2. The Range of Subpopulation Reenlistment Rates for the FY 71 Cohort at SRB 1

(2) CONUS-to-CONUS Station of Choice. This option, currently not offered, is designed to attract soldiers who are not highly motivated by monetary inducements but who may have strong geographical preferences. The option eliminates a relatively high bonus payment and incurs, instead, a lower cost for a permanent change of station (PCS) move.

d. Cost. In evaluating bonus and policy alternatives, the bonus manager must know the cost of the options available to him; this is required not only to assess the cost effectiveness of policies but also to develop a budget. The CEABREP methodology provides the capability to compute rapidly cost differentials between alternatives.

e. CEABREP System. The automated system design resulting from this study meets the fundamental requirements for managing a bonus program. In Figure 3, the system design is presented. The system begins with current policies (base case). Refined input data, in the form of MOS-unique continuation rates, are used to increase the accuracy of force projections provided by the PIA/YOS Model. The force projection is then evaluated in terms of MOS fill and program costs. If the projected force does not satisfy personnel or funding constraints, known information on the historical effects of prior bonus level and policy changes can be used to formulate new alternatives. These new alternatives result in changes to the projected force and the process is continued until personnel and cost constraints are met. Incorporation of this complex methodology into a single automated system would provide the bonus manager with the capability to identify shortage MOS within a projected force; to assess the cost and effect of alternatives designed to reduce the shortage; and to compare these alternatives to determine their cost effectiveness.

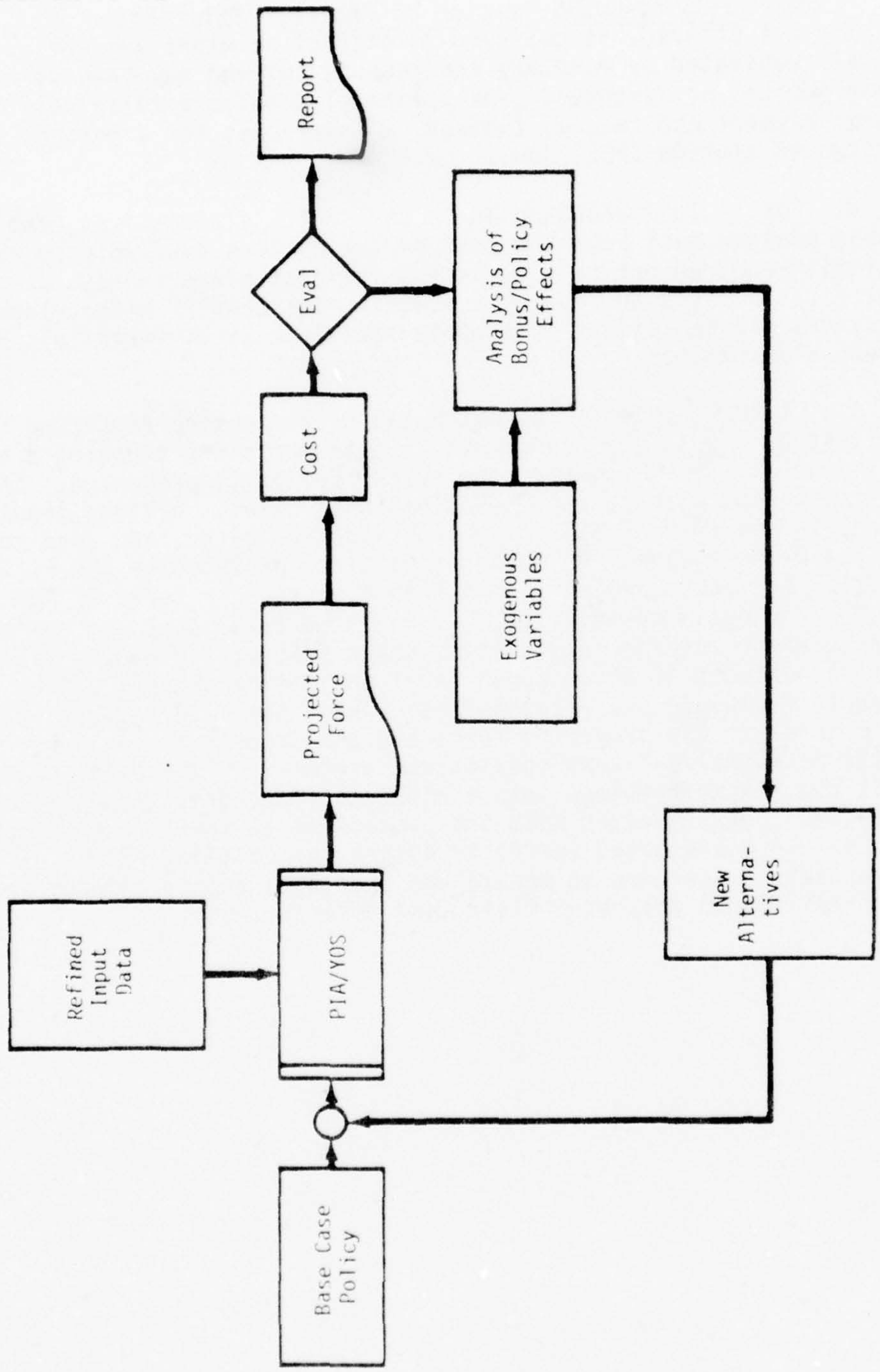


Figure 3. CEABREP Methodology

4. DATA. The CEABREP system requires a supporting data base consisting of five contiguous years of demographic data on soldiers entering the service. This quantity of data is required to measure continuation and reenlistment behavior of soldiers with various years of service. This data base could not be developed from existing sources because the required historical personnel files are retained currently by MILPERCEN for only three years. Accordingly, the CEABREP system design presented within this report could not be fully validated with actual data.

5. ESSENTIAL ELEMENTS OF ANALYSIS. The EEA specified in the tasking directive are discussed below.

a. What are the factors influencing reenlistment? Can this influence be quantified?

(1) Since only the data on FY 71 enlistees were available to this study, the quantitative answer is limited to that group. In spite of the data limitations; however, it can be affirmed that reenlistment-influencing factors can be identified and quantified.

(2) The most important factors influencing the reenlistment behavior of FY 71 accessions were race, education, pay grade, and the number of dependents. Estimating relationships were derived to predict reenlistment as a function of these variables and the SRB. These estimating relationships are presented in Chapter 4.

b. Does the enlistment bonus, when used in conjunction with the SRB, become a lower cost method of providing fill to an MOS? If so, what SRB level? This EEA could not be addressed during the study because of data limitations discussed in Chapters 1 and 2. Only the FY 71 cohort file was available and the enlistment bonus was not offered in FY 71.

c. Are there other cost alternatives that could be used in lieu of or in conjunction with the SRB to provide fill to MOS? Yes. Specific examples include restoration of the CONUS-to-CONUS station of choice reenlistment option and induced reclassification whereby soldiers in surplus MOS are encouraged to reenlist for shortage MOS. These alternatives were shown to be cost effective at the MOS level, but were not recommended as general reenlistment inducements.

6. OBSERVATIONS. The major observations resulting from this study of the reenlistment process are as follows:

a. Reenlistment factors can be developed and quantified using historical reenlistment data. These factors can be used to provide

a comprehensive view of reenlistment behavior. Observations relevant to three- and four-year enlistees of the FY 71 cohort are:

(1) The most significant variables as predictors of reenlistment behavior for FY 71 accessions were: race, education, pay grade and the number of dependents.

(2) The best single discriminator of reenlistment behavior is race. The Black racial group reenlisted at a rate approximately double the rate of Whites and Others at all SRB levels.

(3) Within the education category, GED high school graduates exhibited the highest reenlistment rate and those with some education beyond high school demonstrated the lowest propensity to reenlist. At the SRB 1 level, high school diploma graduates reenlisted at a slightly higher rate than non-high school graduates; however, high school diploma graduates were influenced by increased bonus levels to a greater extent than non-high school graduates.

(4) Soldiers in pay grades E-4 and above consistently displayed higher reenlistment rates than individuals in pay grades E1-E3. Those in pay grades E1-E3 had low reenlistment rates at the SRB 1 level compared to soldiers in grade E4 and above, and little improvement was noted as the bonus level increased.

(5) At the SRB 1 level, the difference in the responses of soldiers with dependents and those without dependents was not significant. As the bonus level was increased, individuals with dependents exhibited higher reenlistment propensities than those without dependents.

(6) The general trends in reenlistment which emerge when viewing the four retention factors (race, education, pay grade, number of dependents) both in concert and in isolation reinforce the need to view the attributes of the soldier in more than one dimension. The multidimensional view permits improved estimates of the kind of soldier the Army will attract with an incentive policy and where, if possible, to focus that policy.

b. Force projections at the MOS/grade/year of service level of detail can be improved using MOS-unique continuation rates developed for the CEABREP system.

c. There are cost effective alternatives to high SRB levels. These alternatives can provide flexibility to managers and appeal to a wider spectrum of potential reenlistees. Such alternatives should be used to alleviate imbalances in MOS and should not be used as general reenlistment inducements.

d. Implementation of the CEABREP system would provide the potential for improved management of the incentives program through the use of automation. The system would provide the capability of analyzing reenlistment in terms of policies, monetary incentives, and exogenous influences which cumulatively constitute the reenlistment environment.

(1) The data base to support the CEABREP system design does not currently exist. Implementation of the CEABREP system would require that MILPERCEN collect demographic data on accession cohorts, institute data quality assurance procedures, and maintain data spanning at least five years.

(2) The data base acquired to support the CEABREP system would provide a source of data to support other Category 1 Manpower/Personnel studies dealing with the demographic characteristics of Army enlisted personnel.

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CONTENTS

FIGURES

TABLES

Cost Effectiveness Analysis of Bonuses and Reenlistment Policies Study (CEABREP)

CHAPTER 1
INTRODUCTION

1-1. BACKGROUND. The Army has placed increasing emphasis on introducing more sophisticated and effective equipment into its inventory to improve the combat capability of the force and to reduce the number of military personnel needed to operate and maintain that equipment. Despite these efforts, the Army remains a labor-intensive force and must compete with the private sector for its manpower. In testimony on 2 March 1977 before the US Senate Armed Services Committee's Subcommittee on Manpower and Personnel regarding a study performed for that subcommittee, Dr. William R. King stated that, "...the 'total force' of active forces and reserves will need to recruit 1 of every 2 qualified and available male youths in the mid to late 1980's." In regard to recommendations made by the Gates Commission* on the all volunteer force, Dr. King further stated, "...the recommended programs of capital substitution for labor, civilianization, and reenlistment rate improvement, which would reduce the demand for young qualified males, have not been aggressively pursued by DOD." If the Army is to compete successfully for its manpower, then it must have the capability to assess the effects of external and internal factors which influence enlistments and reenlistments and be prepared to use these assessments to sharpen accession and retention programs.

a. Historically, the Army has used bonuses to attract and retain enlisted personnel in military occupational specialties (MOS) that are perceived to be hazardous or unattractive. Bonuses have also been used to retain enlisted personnel who have developed Army skills that are closely related to better paid civilian jobs. Bonuses are paid directly to the service member and may be shifted rapidly between MOS as MOS shortages occur. The bonus program has, therefore, great flexibility and incentive potential. Because of tightening defense budgets; however, the Army must use its bonus dollars in the most efficient and effective manner that will assure the highest number of enlistments/reenlistments at the lowest cost. The Army must also be able to present a sound and measurable case to demonstrate that effectiveness.

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*U.S. President's Commission on an All-Volunteer Armed Force. Report., Washington, U.S. Govt. Printing Office, 1970.

b. In 1974, the US Army Concepts Analysis Agency (CAA) performed a personnel study to determine the cost effectiveness of bonuses.* This study demonstrated that the enlistment bonus was a cost effective management tool. Because of data limitations, however, the study did not include an analysis of the reenlistment bonus. Following efforts by the Army to assemble a data base which would support analysis of the reenlistment bonus, the Cost Effectiveness Analysis of Bonuses and Reenlistment Policies (CEABREP) Study was initiated in 1976 by direction of the Assistant Secretary of the Army for Manpower and Reserve Affairs. Analysis concerning the reenlistment bonus was needed to measure the effectiveness of current reenlistment incentive programs and to determine if alternative incentives could be used to meet manpower objectives at a lower cost.

1-2. PURPOSE. The US Army Concepts Analysis Agency was tasked to conduct a category 1 (Manpower and Personnel) study to develop an automated system that will enable managers to assess the potential costs and effectiveness of alternative bonus levels and bonus policies as management tools to attract and retain personnel. This purpose recognizes that all programs and policies designed to increase accessions and/or retention through incentives (both monetary and nonmonetary) must be integrated into an overall incentives management process. Accordingly, the automated system discussed in this report was designed to project the effects of various incentive policies and to provide a basis for comparing incentive policies. These comparisons will provide personnel managers quantitative rationale by which to select the incentive policy providing the highest probable retention at the lowest cost.

1-3. SCOPE. Because of data limitations, the scope of this study was modified from the original tasking directive to exclude items of analysis which could not be supported by existing Army personnel data. These excluded items are highlighted within this report and the rationale for their deletion is presented in detail in paragraph 1-8, and in Chapter 2.

a. This study report encompasses the following items of analysis:

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*CAA Report SR-74-19, "Cost Effectiveness Analysis of Enlistment/Reenlistment Bonuses," 18 Nov 74, UNCLASSIFIED.

(1) Bonuses offered to induce reenlistments.

(2) Reenlistment incentives as alternatives to high selective reenlistment bonuses (SRB).

(3) Force projection accuracy.

b. The following items were excluded from analysis because of data limitations:

(1) The potential effects of the enlistment bonus on reenlistments.

(2) The effects of external factors such as unemployment on reenlistment.

1-4. ESSENTIAL ELEMENTS OF ANALYSIS (EEA). The EEA pertaining to this study are listed below. As explained in paragraph 1-8 and Chapter 2, data was not available for enlistment bonus recipients. The lack of this data precluded analysis of the second EEA.

a. What are the factors influencing reenlistment? Can this influence be quantified?

b. Does the enlistment bonus, when used in conjunction with SRB, become a lower cost method of providing fill to an MOS? If so, what SRB level?

c. Are there other cost alternatives that could be used in lieu of or in conjunction with the SRB to provide fill to an MOS?

1-5. APPROACH. An overview of the approach used for designing an automated system to assist in management of the Army Bonus Program is shown in Figure 1-1. This approach consisted of identifying the information or tools that the bonus manager requires for directing and assessing an incentives program and establishing the tasks necessary to meet the requirements. (See Figure 1-1.) The tasks formed the basis for the study effort and provided focus for designing an automated system to assist the bonus manager. The following paragraphs, keyed to the requirements shown in Figure 1-1, provide supporting rationale for the study approach.

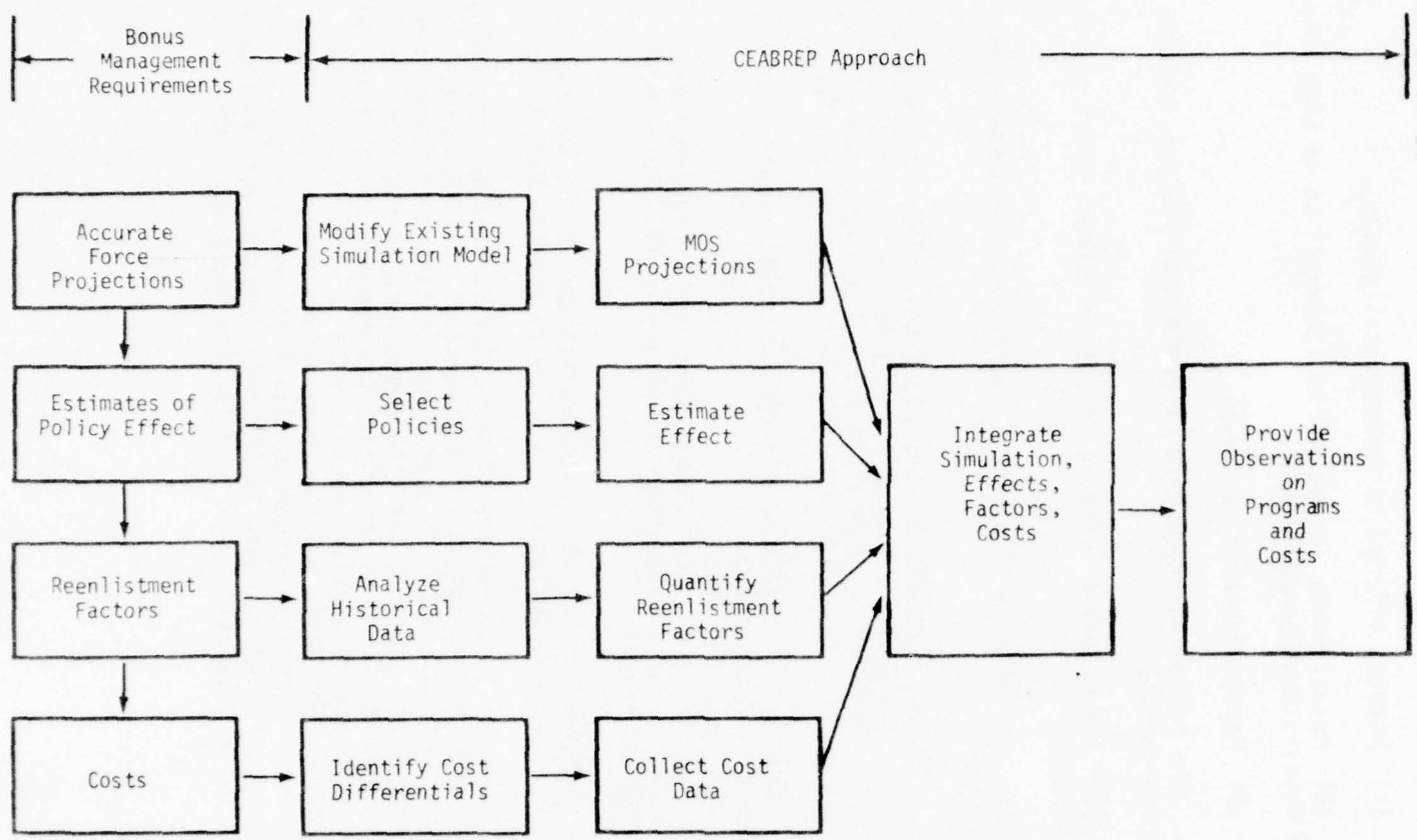

Figure 1-1. Study Approach

a. Force Projections. Bonus management requires accurate and periodic identification of personnel shortfall by MOS. Because this requirement is fundamental, focus was directed toward improving the Army's capability to develop force projections that were accurate at the MOS level. The current method of calculating force projections is based on an aggregated continuation rate that is used for all MOS. (A continuation rate is a probability that a soldier will remain in service one more year.) By developing separate continuation rates for each MOS, improved force projections would result, revealing those MOS requiring the attention of the bonus manager. Improved force projections were obtained by modifying the input to an existing Army personnel simulation model.* Modification of an existing model minimized the cost to the Army and avoided duplication of current capabilities.

b. Policy Effects. The reenlistment incentive policies considered in this study were:

(1) The Selective Reenlistment Bonus (SRB): The SRB is currently used to increase the number of reenlistments in designated critical MOS that are characterized by retention levels insufficient to adequately man the force. Two zones of eligibility exist for the SRB:

(a) Zone A: Reenlistments which occur between 21 months and six years of active service.

(b) Zone B: Reenlistments which occur between six years and ten years of active service.

The amount of the SRB (zones A and B) is computed as follows:

Basic pay times years or fractions of years of additional obligated service times SRB multiplier or designator = SRB. The SRB designator (e.g., SRB 1...SRB 5) is established by Department of the Army based on the criticality of the MOS. (See AR 600-200 for complete discussion of bonus eligibility and payments).

(2) Induced MOS reclassification: This reenlistment incentive offers a minimum bonus payment to soldiers in surplus MOS who voluntarily reclassify into shortage MOS. The bonus payment is offered in lieu of increasing the bonus level for soldiers already serving in the shortage MOS. This incentive is not currently offered.

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*Personnel Inventory/Year of Service Model (PIA/YOS) see Chapter 2, pp 2-2.

(3) The CONUS-to-CONUS station of choice option: This reenlistment option guarantees assignment to a CONUS station of choice for soldiers serving in CONUS. The CONUS station of choice is currently offered only to soldiers serving in an overseas area. (See AR 601-280 for option eligibility and prerequisites.)

These three policies were selected for the following reasons: these policies have the potential of favorably influencing reenlistments thereby resolving MOS shortages; the policies can be focused directly on problem MOS; and they are policies which are either currently in effect (SRB and reclassification) or were used (station of choice) during the time frame relevant to the study data base used in the study. The potential effects of each policy could therefore be estimated in terms of its cost effectiveness.

c. Reenlistment Factors. A soldier's decision to reenlist was assumed to be a function of many variables or influences. Some of these variables are demographic, some economic, and some social. Study efforts were directed toward an examination and quantitative analysis of reenlistment behavior and influences in order to develop predictors that could be used to project reenlistments. This analysis was performed on historical data consisting of the personnel records of all enlisted service members who entered the Army in FY 71; included in the data were the month and year of each person's separation or first reenlistment. (This file, called the FY 71 cohort file, is discussed in more detail in Chapter 4.) The analysis of reenlistment factors was performed by dividing the historical records into subgroups stratified by such variables as age, race, and education, and then correlating the reenlistment behavior of these groups with bonus levels.

d. Costs. The costs evaluated in this study consisted of those expenses which differentiate bonus policies. Costs which would be incurred regardless of policy (e.g., pay and allowances) are not considered. Thus the CEABREP study focuses on the differences in costs between various bonus and reenlistment policies. The elements of expense which reflect these differences are:

(1) Cost of the bonus (SRB)

(2) Training costs

(3) Permanent Change of Station (PCS) costs

Each of these cost categories represent expenses potentially incurred in the policy alternatives discussed in the previous paragraph. For example, SRB costs relate to the SRB levels offered a soldier; training costs are significant where MOS reclassification

is involved and PCS costs are relevant to the station of choice reenlistment option. Cost areas such as nominal soldier pay/benefits and accession costs (recruitment and initial Army training) are either sunk costs or are common to all soldiers regardless of the manner in which each soldier is persuaded to reenlist. Accordingly, this study focused on the cost differentials between incentive policies to highlight the cost effectiveness of each policy.

e. Task Integration. By estimating the impact which a policy has on reenlistments, the projected effect of the policy on the Army force can be gauged using the previously mentioned ODCSPER simulation model. Separately, costs to support the policy can be determined. The policy can then be accepted, modified, or rejected based upon an evaluation of its cost effectiveness.

1-6. ASSUMPTIONS. Major assumptions pertinent to the study and specialized in the tasking directive are:

a. The demographic characteristics associated with accessions to an MOS will not change unless the level of the enlistment bonus is changed.

b. If one MOS is added to the list of MOS authorized an enlistment bonus and if the added MOS is similar to MOS previously authorized an enlistment bonus, there will be no net change in the total number of bonus recipients.

c. At a given SRB level, the average SRB payment to a reenlistee is independent of MOS (SRB payments are computed based on base pay times the number of years of reenlistment obligation times SRB multiplier or SRB level).

d. Continuation rates (probabilities of remaining in service at least one more year) after the 4th year of service are independent of initial enlistment obligations.

e. The values of exogenous random variables such as unemployment rates that impact on reenlistment will remain relatively stable.

f. The Objective Force Model* will provide the desired MOS populations by grade and years of service by which to gauge MOS shortfall.

g. A peacetime environment will continue.

1-7. STUDY LIMITS. Limits specified in the tasking directive for this study are:

a. Limit analysis to MOS authorized a bonus and a representative set of plausible bonus policies as determined by the sponsor.

b. Analysis of the effect of the SRB will be limited to zone A bonuses.

1-8. VALIDATION OF CEABREP SYSTEM. Operation of the CEABREP system discussed within this report requires supporting data bases of five chronologically consecutive data files. These files, called cohort files, contain demographic data on soldiers grouped by the fiscal year these soldiers entered the Army. The structure, content and rationale for these files are discussed in detail within the study report. Although one cohort file was available to develop the methodology for the CEABREP system, the five consecutive supporting files required to support operation of the system were not. Accordingly, direct validation of the CEABREP system and analysis of CEABREP output could not be performed. This data limitation is discussed in more detail in Chapter 2, paragraph 2-8.

1-9. STUDY REPORT. The remainder of this report presents a detailed discussion of the study methodology (Chapter 2); a discussion of the techniques used to develop MOS continuation rates (Chapter 3); development and analysis of reenlistment factors (Chapter 4); and a discussion of bonus alternatives (Chapter 5). The study observations are presented in Chapter 6, and a series of appendixes provide detailed information to support specific discussions within the main report.

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* A subsystem of the PIA/YOS Model used by ODCSPER to determine the number of soldiers required in each MOS/grade/year of service to satisfy Army operational requirements.

CHAPTER 2

METHODOLOGY

2-1. OVERVIEW. A diagramatic overview of the methodology to assess the cost effectiveness of bonuses and reenlistment policies is presented in Figure 2-1. Existing Army personnel policies, bonuses, costs, and populations constitute the base case. Since the purpose of CEABREP is to determine the least cost method of providing fill to a shortage MOS, the base case serves as a baseline for comparison of alternatives. The CEABREP methodology involves an iterative procedure that treats the projected force as a dependent variable and alternatives to improve the projected force as independent variables. A dynamic simulation model provides the means of performing this interative procedure with output furnished as force projections from one to four years into the future. The projected force is portrayed by the simulation model as MOS populations distributed by grade and year of service (e.g., MOS 11B - grade E5 - sixth year of service). MOS imbalance (over/short) is determined by comparing the projected force with projected requirements. The cost of the projected force, if it is the base case, is the cost of continuing current programs. The bonus manager evaluates an alternative projected force and its cost (relative to the base case) to determine if personnel and funding requirements are acceptable. If personnel projections and costs are satisfactory, action can be taken to implement the policy. As shown in Figure 2-1, if the alternative is unsuitable, the manager must formulate a change in policy, estimate the effect of the change and evaluate the impact relative to the current force. The estimated impact of exogenous variables such as unemployment is an integral part of CEABREP methodology because they may influence the effect of a new policy. Each alternative must be expressed in terms of revised accession and retention estimates before the alternatives can be evaluated with the simulation model. The simulation model then generates a new force projection and relative cost based on the new alternative. This process may be continued until the projected force meets personnel and cost requirements. The remaining paragraphs in this chapter discuss the components of the CEABREP methodology in more detail and provide supporting rationale.

2-2. FORCE SIMULATION. A key component of the methodology is the PIA/YOS Model; this is a computer-based model used to project current MOS inventories up to four years into the future. The operation of PIA/YOS is shown in general form in Figure 2-2.

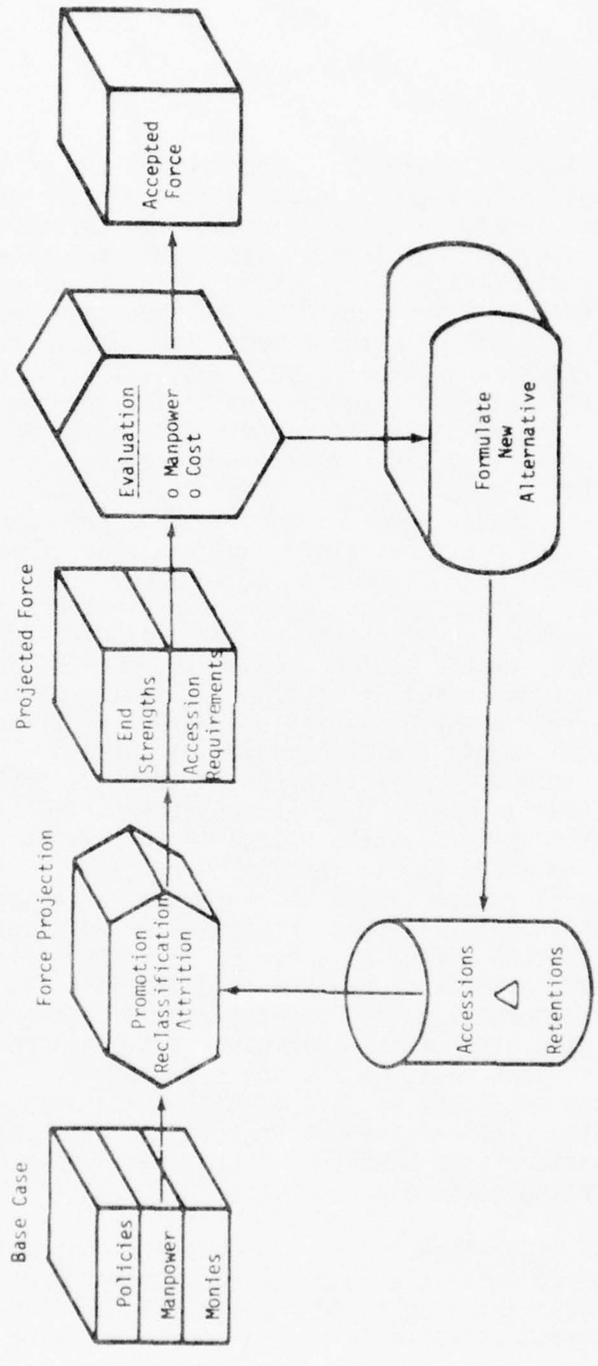


Figure 2-1. An Overview of Study Methodology

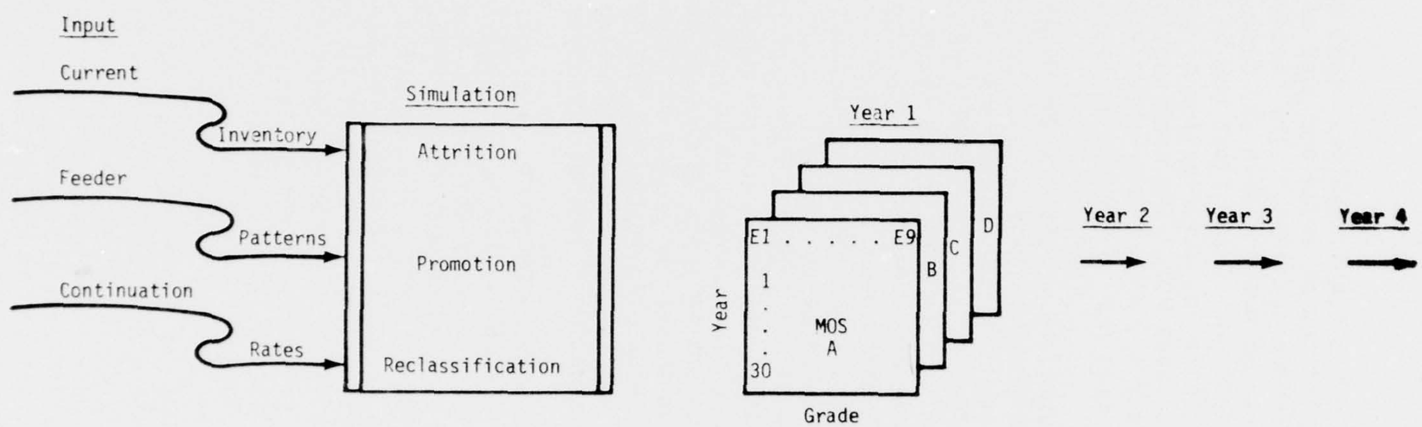


Figure 2-2. Personnel Inventory Analysis/Year of Service Model (PIA/YOS)

a. The PIA/YOS Model requires input data consisting of: current MOS populations by grade and year of service; continuation rates; and "feeder patterns." The "feeder patterns" describe personnel flows or movement within and between MOS due to promotion or reclassification. These flows may be conceptualized as road maps used to route the distribution of personnel to meet Army requirements for each MOS. The continuation rates are probabilities, expressed for each MOS by grade and year of service, that a soldier will continue in service at least one more year.

b. The functions of the PIA/YOS Model are to simulate the effects of time-phased attrition, MOS reclassification, and promotion. The beginning MOS populations are updated or "aged" using the continuation rates. The model then simulates promotion and reclassification according to the feeder patterns. The resulting MOS populations are compared to Army requirements at each grade to determine MOS shortages or overages and thereby assist in determining accession requirements. The PIA/YOS Model is used by ODCSPER and MILPERCEN to forecast losses and promotion requirements; to identify inadequate career progression within MOS; and to develop budget estimates for the bonus program. The PIA/YOS simulation model is inherent to the CEABREP study methodology and is used to support analysis of changes to a starting population resulting from changes in policy or bonus levels. However, the continuation rates used in the PIA/YOS Model were too highly aggregated for use in the study. Therefore, refinements were made to these continuation rates, as discussed in the next paragraph.

2-3. REFINED SIMULATION INPUT. A significant determinant in the value of the CEABREP system is the quality or accuracy of the projected force generated by the PIA/YOS Model. Because the projected force is used to measure the effects of changes in policy or bonus at the MOS level, the projected force must reflect as accurately as possible the flow of people within MOS and between MOS (reclassification). The capability of the PIA/YOS Model to compute these flows accurately depends on the precision of the continuation rates and feeder patterns. In the past, the continuation rates used as PIA/YOS Model input were Army-wide continuation rates. These rates were developed by dividing the total current Army strength in one year of service by the preceding year of service strength of the total Army one year earlier. Although historical data were available by MOS, grade, and year of service, the complexity of the flows of people between MOS (MOS migration) impeded development and application of MOS-unique continuation rates. Reclassification from one MOS to another, for example, represents a loss to one MOS and a gain to another with no net change in Army strength. However, a reclassification and subse-

quent separation represent losses to two MOS but only one loss to the Army. Attempts in the past to reconstruct these dynamic flows in the form of MOS continuation rates were unsuccessful. As shown in Figure 2-3, the use of Army-wide continuation rates avoided the complexity of MOS migration but resulted in force projections which were accurate only at an aggregated level. This level of aggregation restricted effective management because of lack of confidence in the accuracy of the projections at the MOS level of detail. To improve this degree of resolution, the CEABREP Study developed a methodology for deriving MOS-unique continuation rates and then integrated that methodology into the PIA/YOS Model by modifying the computer program. This new methodology is explained in detail in Chapter 3.

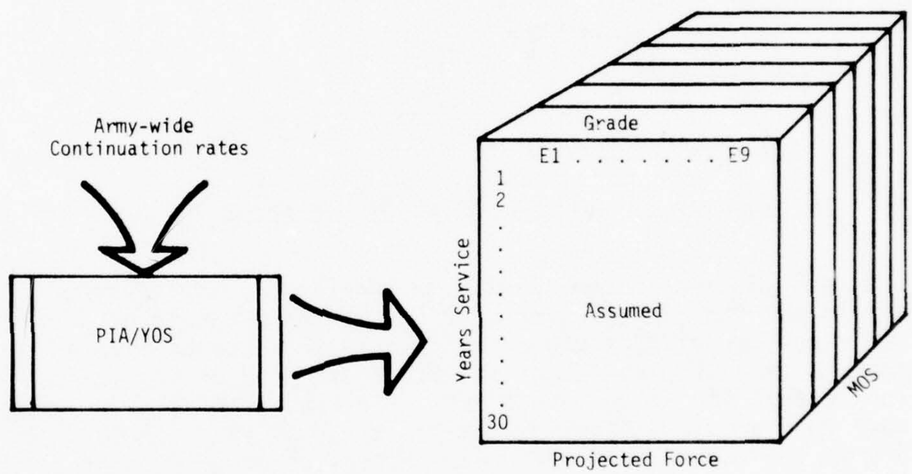


Figure 2-3. Unmodified PIA/YOS Projected Force

a. The derivation of MOS-unique continuation rates represents a significant achievement of the CEABREP Study because these rates contribute to much greater accuracy in force projections under current policies. The effect of the refinements in MOS and term of service continuation rates on the accuracy of the projected force is illustrated in Figure 2-4. Note that an estimated array of projected force data is computed with the modified PIA/YOS model when compared with the assumed array of projected force data of the unmodified model (Figure 2-3).

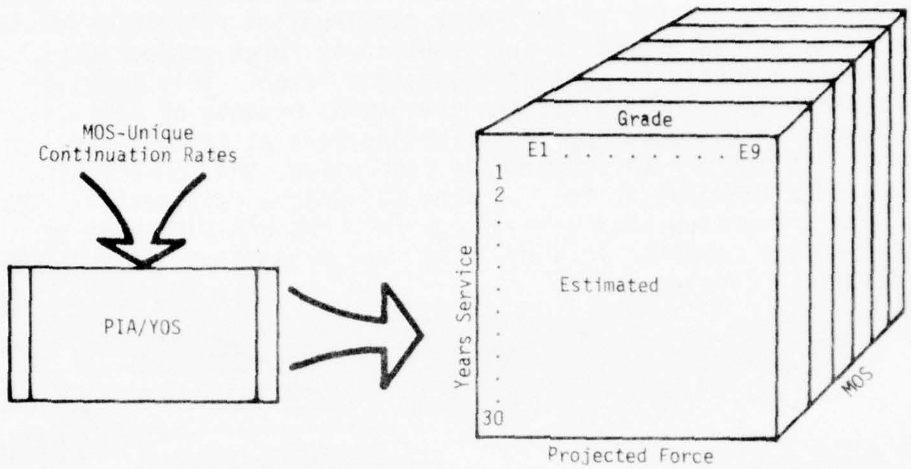
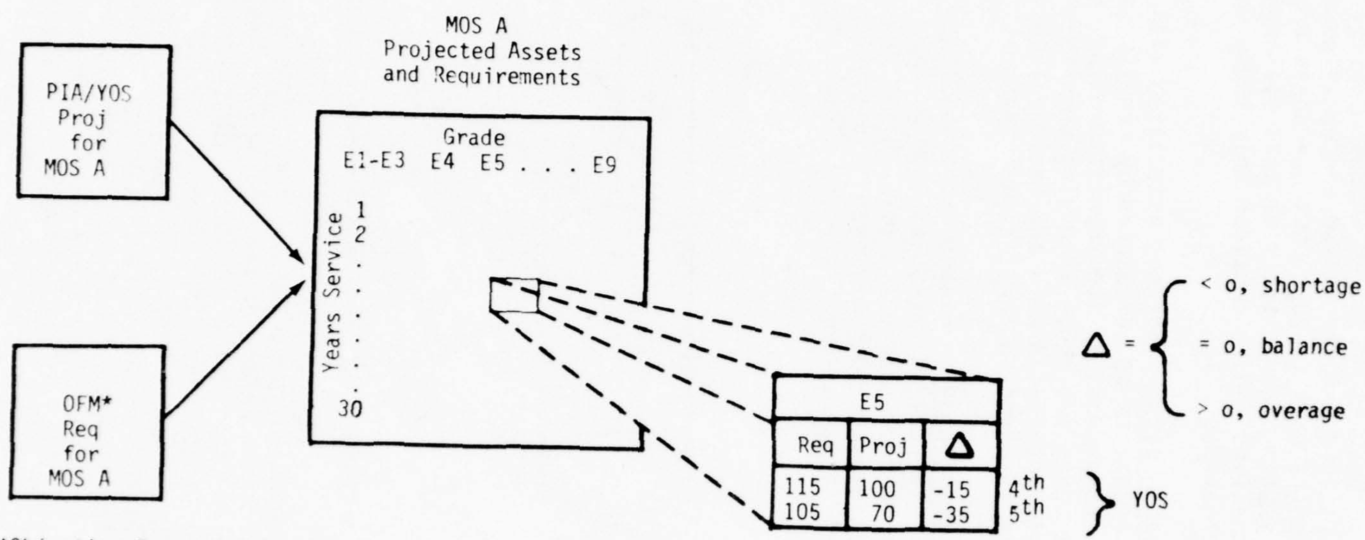


Figure 2-4. Modified PIA/YOS Projected Force

b. Application of the CEABREP methodology, with improved accuracy in the force projection provided by the MOS-unique continuation rates, provides the bonus manager with a capability to analyze the projected force and isolate those year of service populations within MOS which do not meet Army requirements. The example shown in Figure 2-5 highlights a projected shortage in MOS A of E5's in the fourth and fifth year of service under current policies. In this example, the force projected by the PIA/YOS Model indicates that the current policies/bonus level, relative to MOS A, are insufficient to retain first term soldiers in this MOS. In this example, the years of service shown are within range of the SRB and CEABREP provides the manager a capability to evaluate alternative policies to reduce or eliminate the projected shortfall.

2-4. COSTS. There are many costs associated with a soldier. They range from the recruiting cost which is incurred prior to the soldier entering service to retirement costs which are incurred perhaps twenty years later when service is complete.



*Objective Force Model

Figure 2-5. Problem Isolation

a. Scope. In this study, an unequal cost-equal effectiveness formulation is used. Alternatives are constructed such that their effect on reenlistment is equal but the costs are unequal. This permits the system user to focus on cost differentials when comparing alternatives and to consider only those costs which vary between alternatives.

b. Relevant Costs. The cost associated with retaining an enlistee long enough to be influenced by reenlistment policy is assumed to be independent of the reenlistment policy. Therefore, the relevant costs are those involving reenlistment: the SRB, training costs associated with any reclassification, and appropriate PCS costs involved in reenlistment options.

c. Cost Methodology. Figure 2-6 illustrates the reenlistment environment. Currently, accessions are brought into the Army as either three or four-year enlistees. After completing the enlistment term of service, some of these soldiers continue in service becoming part of the career force and others are losses to the Army.

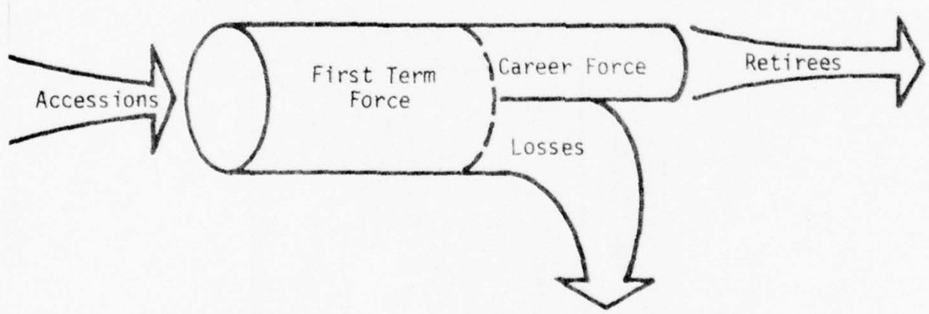


Figure 2-6. The Reenlistment Environment

(1) Inducement programs are focused on the interface between the first term and career forces and are designed to influence the amount of flow into the career force; this focus is required because of the significant difference between the reenlistment rate of first-term soldiers and career soldiers. The reenlistment rate of career soldiers is both higher (nearly double) and more stable than the reenlistment rate of first-term soldiers. The interface between the first-term force and the career force is, therefore, the initial focal point for application of reenlistment incentives.

(2) Within the CEABREP methodology, cost factors to be applied are the differential costs of alternative reenlistment policies designed to maintain a specified flow into the career force. If the SRB level is increased, this is expected to increase the number of reenlistments. Another policy decision such as restoration of the CONUS-to-CONUS station of choice reenlistment option may produce an equal number of reenlistees. It is the total cost of one course of action that must be contrasted with the total cost of an alternative; this comparison enables the manager to select between alternatives on the basis of the costs of operating the programs to obtain a desired effect. The per man costs of training and PCS are readily available from the Office of the Comptroller of the Army; these costs are applied to the number of individuals computed to reenlist for the option. The reenlistment data are obtained separately from analysis of historical data as explained in Chapter 5 and Appendix C.

2-5. EVALUATION. Application of the CEABREP methodology will provide the bonus manager with an improved capability of evaluating a projected force to determine if its personnel strength and costs meet Army goals. MOS fill is evaluated by comparing the projected MOS strength, grade, and year of service populations to the objective force. If the projected force satisfies MOS and cost constraints, the policies and bonus levels may be considered acceptable. If the projection is not satisfactory, changes to current policy can be formulated to resolve the problem. These policy changes, quantified in terms of revised continuation rates, are then input to the PIA/YOS Model to generate a new force projection. This methodology can be applied successively to alternative policies until the bonus manager is satisfied with the solution.

2-6. FACTORS INFLUENCING ACCESSION/RETENTION. There are indications that an individual's decision to enter or continue in the Army is a function of many variables, some demographic, some economic, and some random. Certain economic variables such as bonuses are controllable by Army policy while others such as unemployment are not subject to Army control. The effect of those external and internal factors which can be estimated should be considered when attempting to predict the result of a new policy or bonus. The CEABREP methodology for estimating the effect of

demographic variables on accession and retention uses the accession cohort* data discussed in paragraph 1-5c and the Automatic Interaction Detector III (AID III)** statistical model. This statistical model is an automated clustering routine used to subdivide the FY cohort file into a series of mutually exclusive, collectively exhaustive reenlistment subgroups. The model selects among predicting characteristics (such as race and education) to form subpopulations which exhibit statistically different reenlistment behavior. The model is used to identify the most important variables as predictors of reenlistment. Figure 2-7 illustrates the model output; in this example one of the subpopulations identified by the AID Model within the FY 71 cohort file was defined as Black-E5-single-high school graduate. This subpopulation reenlisted at a rate of 35 percent. (For a complete discussion of AID III and the variables used see Chapter 4). When the subpopulations have been defined, count data on the number of reenlistments and separations are obtained for each subpopulation at each SRB level. If there are 100 or more total separations and reenlistments for at least three SRB levels, linear regression is used to estimate reenlistment as a function of the SRB. If this criterion is not met, random variation in the data will preclude statistically valid regressions. As a means of deriving estimates for the small sample subpopulations, a "joint probability distribution" is constructed from the marginal distributions obtained by viewing the population in terms of one variable at a time. (This technique is explained in more detail in Chapter 4 and Appendix C). The result of these calculations is reenlistment rate estimates for each subpopulation at every SRB level. The effects of exogenous influences (e.g., unemployment) and policy changes on the reenlistment estimates are then developed; these effects are estimated using time lagged linear regression on cohort file data and are used to increase or decrease the reenlistment rate estimates to compensate for expected unemployment rates or policy decisions. (See Appendix C for a more complete discussion of this adjustment process). The result of this analysis is a set of expected reenlistment rates for the various subpopulations under different incentive and policy conditions.

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*The term cohort is used in this report to refer to a group of soldiers who entered the Army in the same fiscal year.

**University of Michigan Institute for Social Research, OSIRIS III, System and Program Descriptions, Vol. I, Section 15, "AID Write-Up", University of Michigan, Ann Arbor, Michigan, 1973.

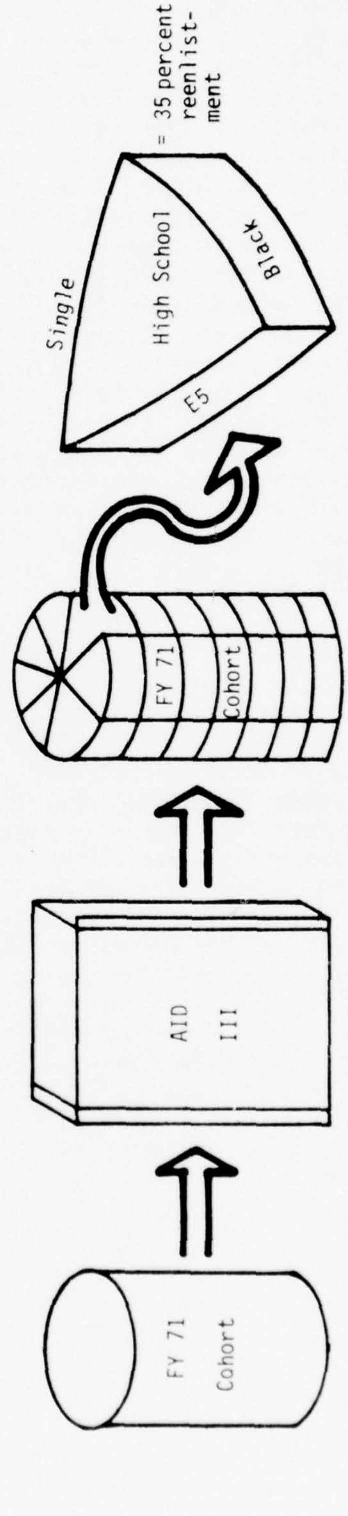
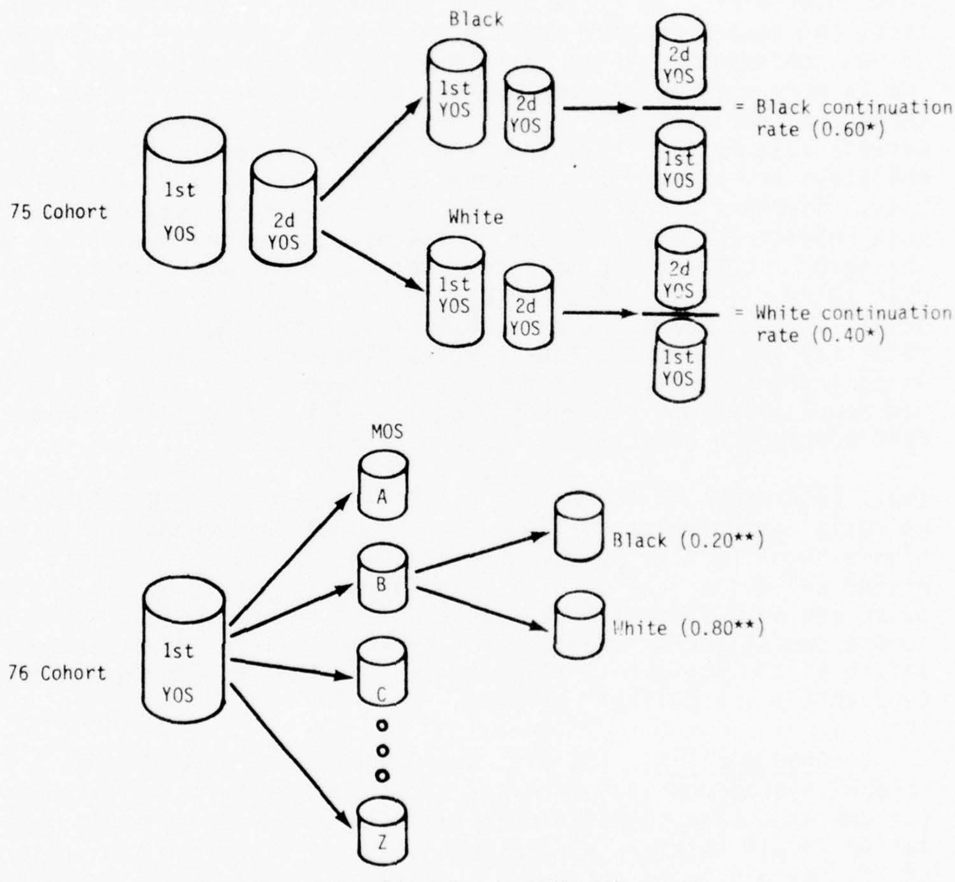


Figure 2-7. Automatic Interaction Detector (AID) III Output

2-7. INTEGRATING POLICY EFFECTS INTO THE CEABREP SYSTEM. The manager has been provided with an improved force projection capability to highlight MOS anomalies in the force and with estimating relationships to show how various subpopulations react to inducements and policy changes. These estimating relationships are used to revise the input to the simulation model and compute a new force projection resulting from changes to bonus levels or policy decisions. As specified in the tasking directive, this study was limited to exclude consideration of zone B of the SRB paid for reenlistments in the sixth through tenth years of service. This limitation permitted analysis and system design to focus on how the continuation rates through the first enlistment (to include the reenlistment process) would vary due to management action. Because the number of people enlisting for a period of more than four years is too small to effect significantly the results of the simulation and is also too small to derive estimates of reenlistment propensities, only the first four years of service continuation rates are considered. The factors influencing reenlistment were discussed in paragraph 2-6 and these factors are used in conjunction with the cohort files to compute continuation rates for the first four years of service.

a. An example will be used to illustrate the process and in the example only two subpopulations will be defined--Black and White racial groups. Figure 2-8 illustrates the use of the FY 75 and FY 76 cohort files to construct a first year of service continuation rate for use at the MOS level of detail. In Figure 2-8, all FY 75 accessions either have entered their second year of service or have left the Army. By stratifying the FY 75 cohort into respective subpopulations (Black or White), separate continuation estimates can be made for the first year of service for each of the subpopulations. The FY 76 cohort which comprises the current first year service population is first stratified by MOS and then by subpopulations within MOS to determine the proportional mix of the current first year of service in each MOS. This proportion is then used to form a convex combination or mixture of the subpopulation rates to provide one single continuation rate for the first year of service for each of the MOS. The FY 74 and FY 75 cohorts can be used in the same fashion to produce a second YOS continuation rate which is representative of the current second year of service force.



Continuation Rate for MOS B - (0.60)(0.20) + (0.40)(0.80) = 0.44

*Notional numbers indicating that 60 percent of the blacks and 40 percent of the whites will continue into the second year of service.

**Notional numbers indicating that the current first year of service population of MOS B is 20 percent black and 80 percent white.

Figure 2-8. Deriving a First Year of Service Continuation Rate Using Cohort Files

b. If the MOS has not been offered an enlistment bonus, the FY 73 and FY 74 cohorts can be used to produce the third year of service continuation rate, but because this rate includes the effects of reenlistment, a set of rates must be derived using the techniques outlined in paragraph 2-7. This set of rates represents available bonus levels and policies. A policy set must then be specified which will provide the expected reenlistment rate for the subpopulations. Stratifying the current third year of service force from the 74 cohort into subpopulations within MOS again permits derivation of a single third year of service continuation rate for each MOS. Fourth year of service continuation rates are calculated using the FY 72 and FY 73 cohorts in the same way that first and second year of service rates were computed. Derivation of MOS continuation rates for the third and fourth years of service is more complicated for MOS which have mixed populations of three and four-year enlistees; in these cases, the third year of service rate must reflect the reenlistment decisions of three-year enlistees and the normal continuation behavior of four-year enlistees. Similarly, the fourth year of service continuation rate must reflect the reenlistment decisions of four-year enlistees and the normal continuation of three-year enlistees who have already reenlisted. The technique to merge these rates is explained in detail at Appendix C. The capability to alter the continuation rates for the third and fourth years of service to reflect bonus or policy decisions allows force projections to be based on policy and bonus decisions and permits basing cost estimates on the current population effected by those decisions.

2-8. DATA REQUIRED TO SUPPORT ESTIMATION OF POLICY EFFECTS. An essential requirement for applying the CEABREP methodology to estimate the effect of policy alternatives on force projections is historical data. The data must include the effects of the policy to be evaluated and it must span a sufficient period of time to permit comparison of reenlistment behavior before and after initiation of the policy. This comparison is the methodology utilized to quantify the policy's effect.

a. Cohort Files. The data base required to support the CEABREP system consists of a series of fiscal year data files that include accession, separation, reenlistment and demographic information on all soldiers who entered the Army since the beginning of FY 71. Each file of the series, called a cohort file, is limited to soldiers without prior service who enter the Army within the same fiscal year. The cohort file is completed when every soldier in the file has either reenlisted or separated. Because separation/reenlistment transactions are required for each soldier, it takes five years (for a four-year enlistment) to complete a cohort file. The personnel data envisioned to support analysis of the

effects of selected Army policies and external factors such as the unemployment rate on reenlistments are the FY 72-FY 73 cohort files. The FY 74-FY 76 cohort files, though currently incomplete, are required to support analysis of continuation rates for the years of service prior to reenlistment eligibility.

b. Data Limitations. Attempts by the Analysis and Computation Branch, MILPERCEN, to create the cohort files necessary to support the CEABREP methodology, were unsuccessful because of data limitations. The only cohort file that was available for this study was the FY 71 cohort. This hindered the application of the CEABREP methodology; estimates of policy effects, could not be quantified and MOS continuation rates for the first four years of service could not be developed. Although data in the FY 71 cohort file were not sufficient to apply the complete CEABREP methodology, some of the methodology could be verified and intermediate results on the effects of bonuses were obtained. Appendix C discusses in detail the input data requirements and outputs that would be obtained from applying the complete CEABREP methodology.

2-9. SUMMARY. The methodology for the CEABREP system is summarized in Figure 2-9. This figure incorporates the specific components of the CEABREP system discussed in the preceding paragraphs. The system begins with a base case policy and the PIA/YOS Model is used to project a force which can be evaluated in terms of both people and costs. If the projected force does not meet requirements, the user analyzes the projected force problems and formulates new policy alternatives for resolving these problems. Alternative policies are then quantified in terms of revised continuation rates and provided as new input to the PIA/YOS Model. Force projection and subsequent evaluation can continue until the user achieves an acceptable means of influencing reenlistment behavior.

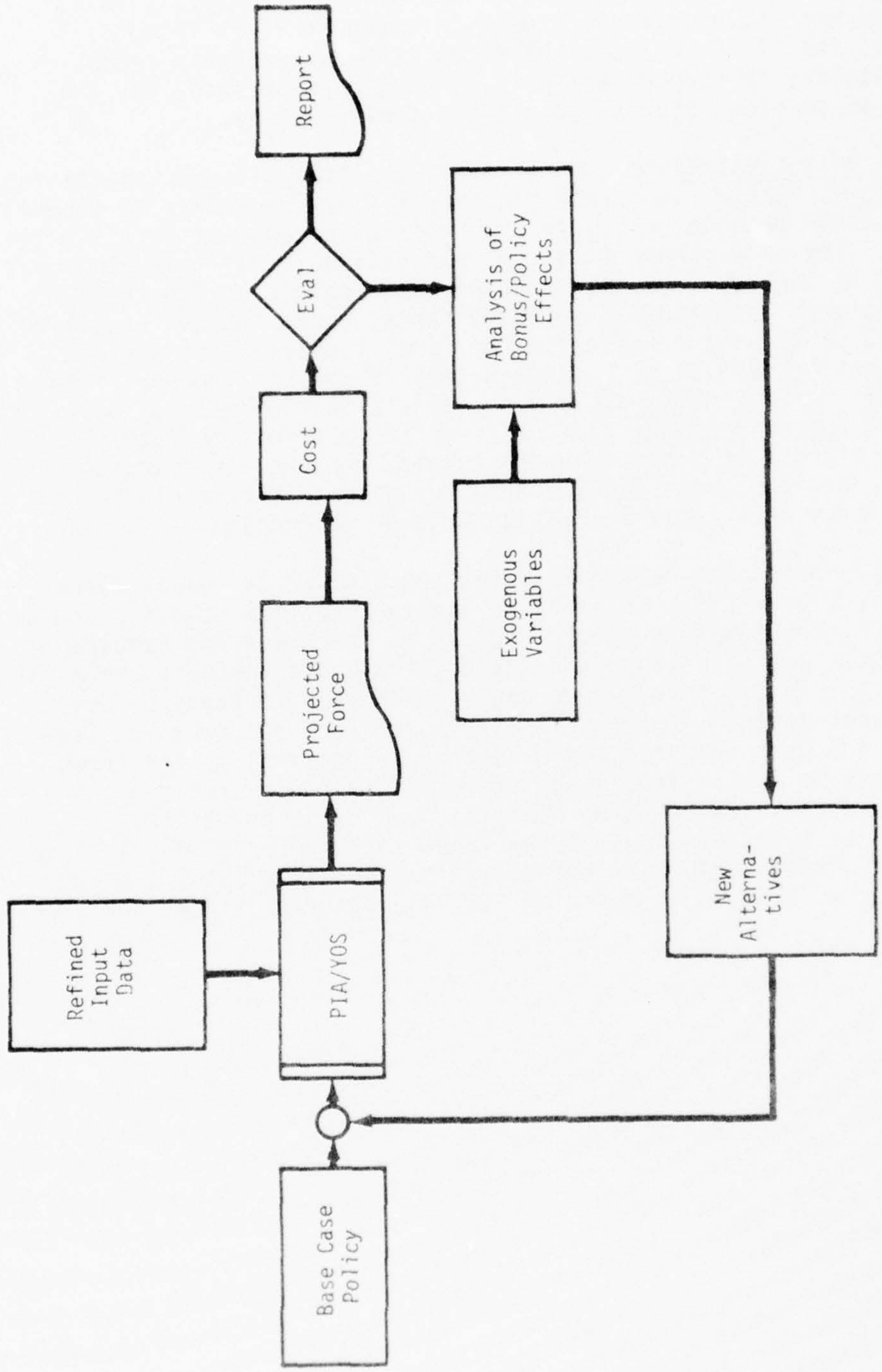


Figure 2-9. Methodology

CHAPTER 3

DERIVATION OF MOS-UNIQUE CONTINUATION RATES

3-1. GENERAL. A continuation rate is a probability that a service member will remain in service at least one more year. The continuation rate is used in personnel projections to calculate the future size of a starting group after an elapsed time of one year. The validity of continuation rates is based on the premise that the historical change in size of a specified population is the best estimate of its future size. The specified populations or groups for which the Army has calculated continuation rates are year of service populations. As discussed in Chapter 2, the projection of the current force or base case provides the basis for evaluating both the acceptability of the force and the policies which shaped that force. Because the accuracy of the projected force is dependent upon the continuation rates used as input to the PIA/YOS Model, these continuation rates perform a pivital role within the CEABREP methodology.

a. The historical method for computing continuation rates is to divide one year's population in a year of service by the previous year's population in the preceding year of service. For example, if, in December 1975 there were 80 people in their 6th year of service and in December 1974 there were 100 people in the 5th year of service, the estimate of the continuation rate from the 5th year of service would be 80/100 or 0.80. The premise is that everyone in the 5th year of service in December 1974 must either be in their 6th year of service one year later or they have left the Army. Such computations are adequate for computing Army-wide continuation rates. If continuation rates are required at the MOS level of detail, this supposition is not valid because of changes in MOS resulting from promotion or reclassification; an individual can be a loss to an MOS but not a loss to the Army.

b. In this study, movement between MOS as a result of either promotion or reclassification is defined as MOS migration. The phenomena of MOS migration is known and accepted in personnel management; to some degree this migration is designed into the MOS structure. The PIA/YOS Model computes the impact of MOS migration by attempting to model the flows explicitly through feeder patterns. Figure 3-1 is a notional example of PIA/YOS type feeder patterns, but restricted to two MOS (A and B) and two grades E1 and E2. In Figure 3-1, the nodes (circles) signify combinations of MOS and grade; N_1 denotes MOS A, grade E1; N_4 denotes MOS B, grade E2, etc. The arcs (arrows) signify potential flows, but the arc value is the opposite of the usual sense. The arcs represent flow

origin only. The precise value of the flow in an arc is determined by the requirement at the terminal node. In Figure 3-1, if an unfilled requirement exists at N_3, 80% of that requirement will be met by promotions in the same MOS (N_1 to N_3) and 20% will be met by MOS reclassification within grade (N_4 to N_3). If N_4 was originally below authorized strength, the magnitude of the shortfall was increased by the flow from N_4 to N_3. Of the total unfilled requirements at N_4, 30% will be met by promotion from N_1 and 70% by promotion from N_2. The unfilled requirements at the lowest grade (N_1 and N_2), if any, are filled by new accessions. In all cases, it is the unfilled requirement that causes flow and determines the amount of flow rather than a programed grade or MOS progression.

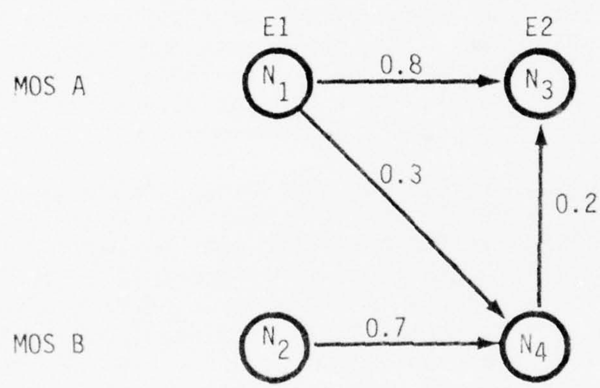


Figure 3-1. Notional PIA/YOS Type Feeder Patterns

c. In deriving MOS-unique continuation rates, it is important to note that MOS migration blurs the distinction between MOS. In Figure 3-1, the subpopulation of N_3 currently holds MOS A and grade E2, but part of that subpopulation consists of people who originally held MOS B and may only recently have been reclassified to MOS A. To further complicate matters, some of the people serving at node N_3 who originated in MOS A have also served in MOS B moving along the arcs from N_1 to N_4 and then N_4 to N_3. Because these flows are important in describing an MOS population, they must be considered in describing how that MOS population will continue.

3-2. INTERIM MOS. The first step in deriving MOS-unique continuation rates is to create interim MOS which have had no gains or losses to the MOS. This involves redistributing the populations

of nodes to reallocate populations to the MOS of origin. To simplify the explanation, the following notation is used: $N_i(x,y)$ is the MOS distribution of the i^{th} node where x is the fraction of the population which originally came from MOS A (first position within parenthesis) and y is the fraction which came from MOS B (second position within parenthesis).

a. Figure 3-2 shows the MOS distribution for node N_1, as $N_1(1,0)$ which means that 100 percent of the current population of N_1 originated in MOS A. Similarly, the distribution of N_2 is $N_2(0,1)$. A node for which a distribution has been determined is defined to be "scanned". It is axiomatic that the distribution of a node can be calculated only if that node received flow from nodes which have been previously scanned. In the example of Figure 3-2, nodes N_1 and N_2 have been scanned. The distribution of the N_3 cannot be calculated until N_4 has been scanned since N_3 receives flow from N_4; however, N_4 depends only upon N_1 and N_2, both of which have been previously scanned.

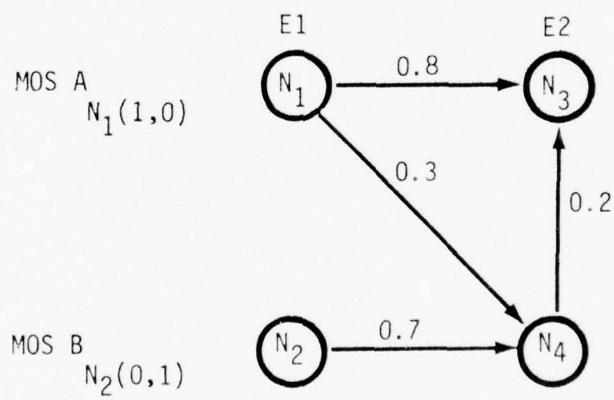


Figure 3-2. The MOS Distribution of Nodes N_1 and N_2

b. Figure 3-3 shows the relevant information needed to compute the distribution of node 4. Note that multiplication of the distribution of a previously scanned node by the number on the arc from the scanned node to the node being scanned gives a partial distribution of the node being scanned. Let $N_{i,j}(x,y)$ denote a partial result where i is the scanned node and j is the node being scanned with x and y defined as before but with unknown values. From Figure 3-3, $N_{1,4}(x,y) = (0.3) \times N_1(1,0) = N_{1,4}(0.3,0)$. This partial distribution of N_4 states that since node N_1 was comprised

totally of MOS A and that 0.3 percent of the population in node N_4 originated in node N_1, at least 30 percent of the population in N_4 originated in MOS A. Similarly, $N_{2,4}$ (x,y) = (0.7) x N_2(0,1) = $N_{2,4}$(0,0.7). Summing across all partial distributions gives the complete distribution of the node being scanned. From our example N_4(x,y) = $N_{1,4}$(0,3.0) + $N_{2,4}$(0,0.7) = N_4(0.3,0.7). Therefore, 30 percent of the node 4 population came from MOS A, while 70 percent came from MOS B. The advantage of this multiplicative technique is that the only information required is the distribution and feeding percentages of the nodes which are directly connected to the node being scanned.

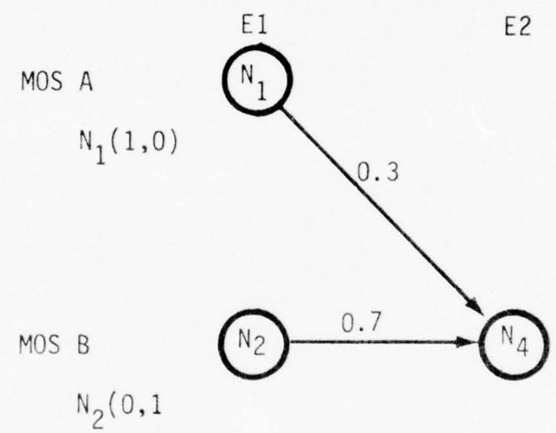


Figure 3-3. The MOS Distribution of Node N_4

c. Figure 3-4 contains all of the information necessary to compute the distribution of node N_3. The fact that there have been intermediate flows to N_4 is summarized in the distribution of N_4 and need not be explicitly considered. Thus:

N_3, (x,y) = $N_{1,3}$ (x,y) + $N_{4,3}$ (x,y), where

$N_{1,3}$ (x,y) = (0.8) N_1 (1,0)

$N_{4,3}$ (x,y) = (0.2) N_4 (0.3,0.7)

and $$N_3(x,y) = N_{1,3}(0,8.0) + N_{4,3}(0.06,0.14)$$
$$= N_3(0.86,0.14)$$

For larger systems the summarization of information on previous flows in the node distributions greatly simplifies the calculations of subsequent node distributions. To pursue the development of the example, assume that populations are assigned to the nodes representing the 5th year of service as of 31 Dec 74. These populations are shown in Figure 3-5. The node distribution rules which are assumed to be constant for all years of service are now used to reallocate the node populations to the MOS of origin. This process is shown in Table 3-1. For the 6th year of service, Dec 75, the node populations shown in Table 3-2 are assumed and the populations are also reallocated according to node distributions. Dividing the 6th year of service populations by the 5th year of service populations gives estimates of interim continuation rates for MOS A of 0.78 and for MOS B of 0.93. It is not correct to interpret these rates as MOS continuation rates. They have no meaning outside the context of this model--first, because the rates are for interim MOS and secondly, because they are totally dependent on the feeder patterns used to create the rates.

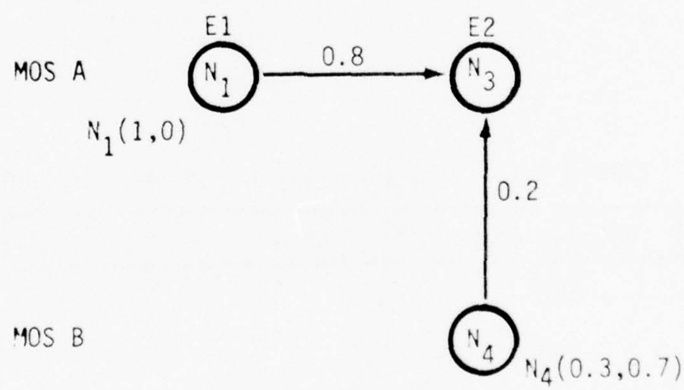


Figure 3-4. The MOS Distribution of Node N_3

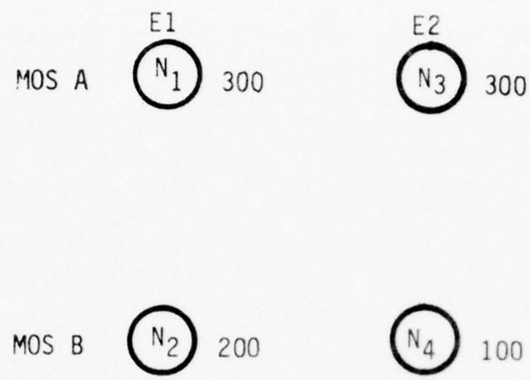


Figure 3-5. Populations of the 5th Year of Service

Table 3-1. December 1974 - 5th Year of Service

Node	Population	Distribution	No. A's	No. B's
N_1	300	N_1 (1,0)	300	0
N_2	200	N_2 (0,1)	0	200
N_3	300	N_3 (0.86, 0.14)	258	42
N_4	100	N_4 (0.3, 0.7)	30	70
Total			588	312

Table 3-2. December 1975 - 6th Year of Service

Node	Population	Distribution	No. A's	No. B's
N_1	200	N_1 (1,0)	200	0
N_2	150	N_2 (0,1)	0	150
N_3	250	N_3 (0.86, 0.14)	215	35
N_4	150	N_4 (0.3, 0.7)	45	105
Total			460	290

3-3. TRANSFORMING INTERIM RATES. The next step in the process is to convert the interim continuation rates, by year of service, into rates that can be applied to the MOS. This is done by combining the continuation rates at each node according to the MOS distribution of that node. For the example, these computations are shown in the following table:

Thus Table 3-3 provides a separate continuation rate by year of service for each MOS and grade. To apply the continuation rates in projecting a force in time, the rates must be applied at the grade level of detail. It should be noted that derivation of these continuation rates requires the arc flows or "feeder patterns" be defined as input to the algorithm.

Table 3-3. Continuation Rates for the 5th Year

Node	Distribution	Rate (convex combinations of pure rates)
N_1	(1,0)	(0.78 x 1) + (0.93 x 0) = 0.78
N_2	(0,1)	(0.78 x 0) + (0.93 x 1) = 0.93
N_3	(0.86, 0.14)	(0.78 x 0.86) + (0.93 x 0.14) = 0.80
N_4	(0.3, 0.7)	(0.78 x 0.3) + (0.93 x 0.7) = 0.88

a. The feeder patterns are defined in current personnel regulations/policies and are accurate for service personnel who progress by grade and MOS "according to plan". These feeder patterns, however, cannot incorporate unprogramed MOS reclassifications requested by the individual for medical reasons or personnel preference. Precise definition of all MOS flows is, therefore, unlikely because of these unprogramed flows or "phantom feeders". The feeder patterns are a best estimate only of MOS flows. Because the MOS-unique continuation rates are developed from actual MOS/Grade/YOS (node) populations including the unprogramed portion of the population, these rates may be greater than 1. For example, the population of MOS A in the 6th year of service may be larger than the MOS A 5th-year population because of an influx of reclassified personnel from MOS B who were in their 6th year of service.

b. The example of this chapter considered only two grades and two MOSs. Derivation of MOS-unique continuation rates for the full range of MOS and grades is computationally more complex. A more rigorous exposition of the technique expanded to consider all grades and MOS is presented in CAA Technical Paper, CAA-TP-77-3*. To illustrate results, the continuation rates computed for the maneuver combat arms are shown in Appendix D.

c. The MOS-unique continuation rates have been incorporated into the CEABREP process by replacing the Army-wide continuation rates as input to the PIA/YOS Model. Because the MOS rates accurately reflect the historical continuation of personnel, the capability of the PIA/YOS Model to project MOS populations has been increased. The ability to calculate and plan manpower programs has, accordingly, been significantly improved.

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*US Army Concepts Analysis Agency, "Derivation of MOS-Unique Continuation Rates", Technical Paper CAA-TP-77-3, Bethesda, MD, Apr 77.

CHAPTER 4

DEVELOPMENT AND ANALYSIS OF REENLISTMENT FACTORS

4-1. GENERAL. Individually, a soldier's decision to reenlist in the Army may be based on a wide variety of factors. These factors or influences may be social considerations such as peer relationships; economic influences like pay and/or bonuses; professional views such as promotion and job satisfaction; education; or ethnic considerations. The preceding examples are but a few of a potentially wide range of factors individually or collectively influencing reenlistment behavior; these influences may result in both positive and negative responses. The combinations of these factors comprise a broad spectrum of stimuli affecting individual reenlistment behavior. This spectrum is too broad to provide useful insights concerning the predictive reenlistment of a single soldier. Collectively, however, soldiers exhibit reenlistment trends and patterns, amenable to analysis, from which factors can be extracted and used for predicting reenlistment behavior. Identification of such factors can provide the bonus manager with a powerful capability to anticipate MOS shortages or excesses and shape policies or programs designed to attenuate their impact on the active force. In the context of the CEABREP system, these factors are used to define the historical reenlistment behavior of specific groups of soldiers and to estimate first-term reenlistment rates of the current force; these estimates serve as input to the PIA/YOS Model. These reenlistment factors should not be confused with the MOS-unique continuation rates discussed in Chapter 3; the MOS-unique continuation rates operate upon the personnel inventory within an MOS from one year to another and, as such, address the question: How many? The reenlistment factors, by focusing on specific groups of soldiers and their behavior, address the question: Who will/won't? The remainder of this chapter presents in detail the data and data structure from which the reenlistment factors were developed; discusses the derivation and use of the reenlistment factors; and provides an analysis of their significance in shaping and assessing accession or retention programs within the CEABREP system.

4-2. COHORT DATA AND STRUCTURE. The reenlistment factors developed for the CEABREP system were derived from analysis of the personnel records and reenlistment behavior of soldiers who entered the Army in FY 71. These data collectively comprise a file called the FY 71 cohort file. The FY 71 cohort file contains demographic information on each non-prior service soldier for 38 separate variables. The FY 71 cohort was used to develop the reenlistment factors because of the requirement to have separation/reenlistment

information on each soldier; this required separation/reenlistment data through FY 75 for those soldiers who had enlisted for four years. More current data to support FY 72 and FY 73 cohort files was not available for this study. The file was created by the Analysis and Computation Branch, Personnel Information Systems Directorate (PERSINSD), at MILPERCEN, using the United States Army Recruiting Command (USAREC) Modern Volunteer Army File, the Enlisted Master File, and the Consolidated Gains/Loss File as source data. Data are collected on the 38 variables at the time of accession, during service, and at reenlistment or separation. The cohort variables and source of each element are shown in Table 4-1.

4-3. DERIVATION AND USE OF REENLISTMENT FACTORS. The variables shown in Table 4-1 were selected for analysis because collectively they offered the potential of describing the "whole man." The large number of variables and the close relationship between some variables (e.g., marital status, number of dependents), however, indicated that these variables required screening to determine which would provide the most information concerning reenlistment behavior. This screening process using FY 71 cohort data was accomplished with the AID III statistical model. The following discussion describes the AID Model; the analysis of the FY 71 cohort; and how that cohort was delineated into subpopulations for which reenlistment factors were developed.

a. Aid III Model Operation. The AID Model provides a means to define subpopulations which demonstrate homogenous behavior in terms of a dependent variable, such as the rate of reenlistment, when many independent variables are available. The AID Model will accept up to 31 values for each independent variable. Using reenlistment as the dependent variable, the model identifies the one variable that will allow the parent population to be split into two subpopulations that exhibit the greatest difference in reenlistment rates. Each of these subpopulations is divided further and the process continues, either through a predetermined number of subpopulation splits or until the size of the subpopulations fall below a predetermined value. (These limits are established by the user). The advantage of this technique is that while all independent variables are considered, only those which exert the most influence on reenlistment are selected.

Table 4-1. Cohort Variables and Data Sources

Variable Number	Variable Name	Source
1	Age at Enlistment	G/L[a]
2	Enlistment Term of Service	G/L
3	Separation Program Designator	G/L
4	Enlisted/Drafted Status	MVA[b]
5	Lottery Number	MVA
6	Race	EMF[c]
7	AFQT Test Scores	MVA
8	Sex	EMF
9	Education	EMF
10	Primary MOS	EMF
11	Career Management Field	EMF
12	Duty MOS	EMF
13	MOS Evaluation Score	EMF
14	Pay Grade	EMF
15	VRB/SRB Pay Grade	G/L
16	VRB/SRB MOS	G/L
17	VRB/SRB Level	G/L
18	Proficiency Pay Status	EMF
19	Marital Status	EMF
20	Number of Dependents	EMF
21	Enlistment Option	MVA
22	Training Committment	MVA
23	State (Home of Record)	MVA
24	Assignment Code	EMF
25	Assignment Location	EMF
26	Recruiting Main Station	MVA
27-33	Army Qualification Battery Test Scores	MVA
34	Transaction Number	G/L
35	Transaction Date	G/L
36	Transaction Code	G/L
37	Social Security Account Number	G/L
38	Zip Code (Home of Record)	MVA

[a]MILPERCEN Gains/Losses File

[b]USAREC Modern Volunteer Army File

[c]MILPERCEN Enlisted Master File

Further, by eliminating non-influential variables, the model prevents the number of subpopulations from becoming unmanageable and the size of the subpopulations from becoming too small for statistical significance. An example of results obtained with the AID Model is shown in Figure 4-1. This example reflects at block 1 a parent population with an overall reenlistment rate of 8.9%. Each member of the parent population in this example is known in terms of the three most influential independent variables: term of service, race, and the number of dependents. The AID Model first divides the parent population into two subpopulations, blocks 2 and 3, based on initial terms of service with a reenlistment rate of 4.4% for draftees and two-year enlistees and a reenlistment rate of 11.9% for those with other initial terms of service, respectively. No other variable could be used to subdivide the parent population into two subpopulations that exhibited as great a difference in reenlistment rates. Subpopulation 2 is then further subdivided based on the number of dependents while subpopulation 3 is subdivided by race. Again, these splits result in subpopulations exhibiting the greatest difference in reenlistment rate. In this example, by knowing only three attributes of the population, reenlistment rate estimates can be derived which range from a low of 3.6% to a high of 21.7%.

b. Analysis of FY 71 Cohort. There were 256,479 accession records in the FY 71 cohort file. Prior to performing analysis, the data on the cohort files were checked to eliminate records/variable entries which were illogical (e.g. age = 5). After rejecting records/variables with illogical data, a random sample of the remaining error free records consisting of 46,190 records was used for initial analysis of the FY 71 cohort. Certain preprocessing of the cohort file data was required before using the AID Model because of the dynamics of the personnel system. In the past, bonus levels have been changed to correct observed deficiencies in MOS strength levels. If bonus managers observe reenlistment rates which are unacceptably low, the bonus is raised. If the reenlistment rate is too high, the bonus level is lowered. Because the level of the bonus can serve to boost MOS with low reenlistment rates and to reduce those with high rates, the bonus is, in effect, a leveling agent. The result is that many MOS, for different bonus levels, have similar rates; because one dependent variable used by the AID Model is the reenlistment behavior of the soldier, the significance of the SRB as an independant variable may be diminished by the leveling effect of the SRB. To compensate for this possible effect, the FY 71 cohort data was stratified according to the SRB level which was paid or for which the individual was eligible at the time of separation. AID analysis was then performed on the stratified subsets. By redefining the error-free parent population into stratified SRB populations, the marginal effect of each bonus level could be retained.

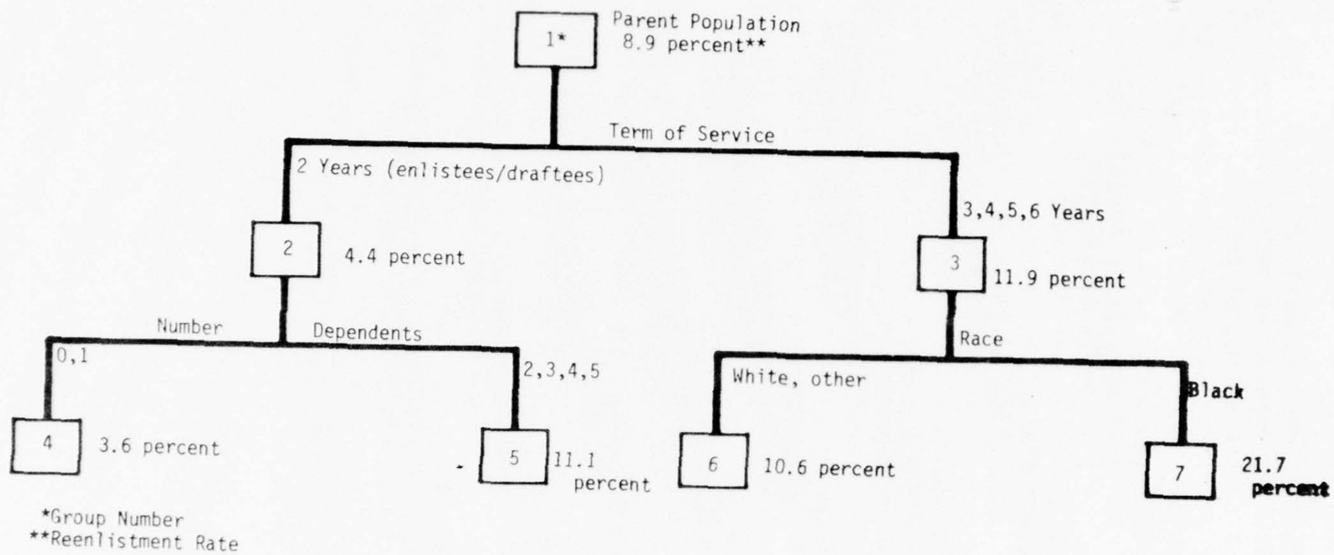


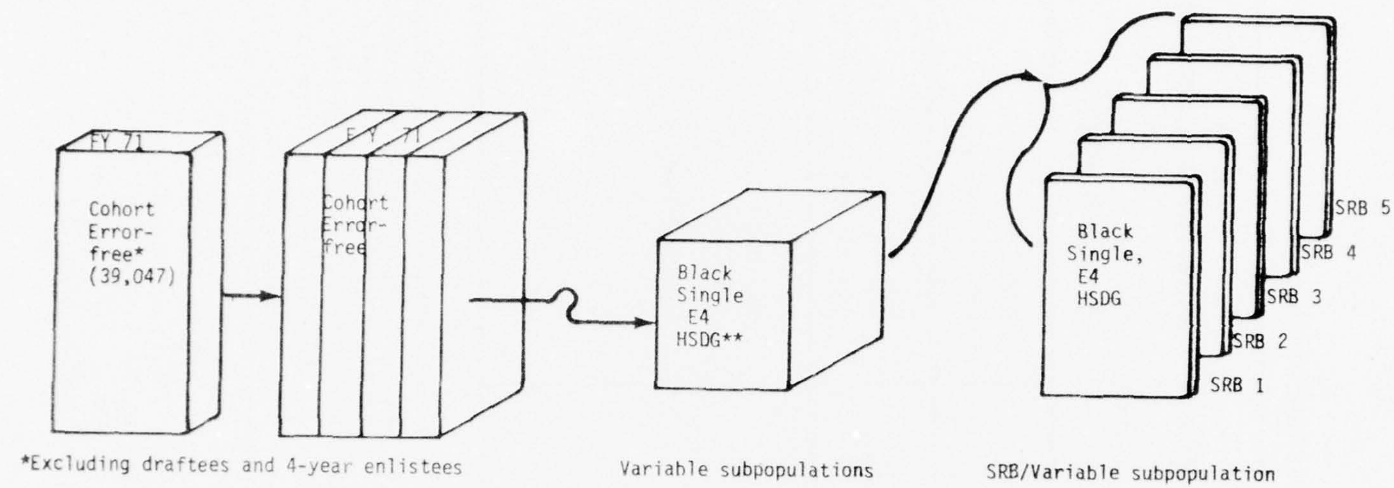
Figure 4-1. An Example of the Automatic Interaction Model Results

(1) Selection of Reenlistment Variables. The results of AID runs on the stratified error-free data set are diagramed at Appendix E. To determine the effect of the SRB, identical subpopulations defined by attribute sets are required at each SRB level in order to observe the change in reenlistment rates as a function of the SRB when other factors are held constant. A cursory examination of the AID splits at Appendix E reveals that the AID trees are not identical at all levels of the SRB. This disparity may result from correlation between variables such as marital status and number of dependents and the random variability in the data. A more detailed examination of these AID trees reveals that, although the order of splits varied between SRB levels, the same general set of variables and classes within variables appeared at all SRB levels. These variables were: term of service, race, pay grade, number of dependents, and educational level. Based on these five selected reenlistment variables, an error-free data set was then extracted from the FY 71 cohort file. There were 174,228 records that had valid entries for these five variables. These records, however, included two-year enlistees and draftees which represented a category of soldier no longer in the force. Accordingly, the error-free sample was reduced by excluding the two-year term of service soldiers from the sample. This exclusion reduced the sample from 174,228 records to 39,047. (This reduction is particularly significant at the SRB 2 level which had a remaining population of only 512 records out of the sample of 39,047 records). The term of service variable within the AID trees in Appendix E appeared to discriminate only between soldiers with two-year service obligations and soldiers with three or more years of obligated service. Because two-year enlistees/draftees had been excluded from the error-free sample, this variable was no longer significant and was discarded. The remaining variables and the classes or categories within each variable used to define reenlistment subpopulations are shown in Table 4-2.

Table 4-2. Classes Within Variables Used to Define Subpopulations

Variable	Classes Within Variable
Race	Black White and other
Pay Grade	E1-E3 E4 and above
Number of Dependents	None One or more
Education	Non-high school graduate High school diploma graduate GED high school graduate Some college education

(2) Definition of Subpopulations. The combination of variables and classes shown in Table 4-2 define 32 mutually exclusive and collectively exhaustive subpopulations (e.g., Black, E4 or above, no dependents, high school diploma graduate). As illustrated in Figure 4-2, the 39,047 error free records from the FY 71 cohort, after excluding draftees and two-year enlistees, were categorized by subpopulation. Each subpopulation was then further distributed across the five SRB levels based on the SRB eligibility that each soldier had at separation or reenlistment. This distribution across SRB levels permitted assessment of changes in reenlistment rates as a function of the SRB level for each of the defined subpopulations. The number of soldiers within each of these 32 subpopulations at each SRB level is shown in Appendix F; also shown is the number of soldiers who reenlisted within each of these subpopulations.



*Excluding draftees and 4-year enlistees

**High School Diploma Graduage

Figure 4-2. Distribution for Variable Subpopulations by SRB Level

(3) Framework for Update. The reenlistment factors which define each of the 32 subpopulations provide a multidimensional view of reenlistment behavior. Reenlistment incentive programs are designed to influence reenlistment behavior. Knowledge of the reenlistment behavior of specific types of soldiers provides a valuable capability to focus incentive programs on these specific populations and anticipate the effect of the policy based on their demonstrated historical behavior. The technique used to measure the historical reenlistment behavior of the 32 subpopulations is discussed in the following paragraph. This technique is discussed in detail to provide the framework for updating when more current cohort data are available.

c. Developing Subpopulation Reenlistment Rates. In this report, reenlistment is modeled as a binomial process where each individual case has only two possible outcomes: reenlistment or separation regardless of type. The unbiased estimator of the true reenlistment propensity is the number of reenlistments divided by the total population. This estimate is a statistic of the sample and, as such, approximates the true reenlistment propensity within confidence intervals. Statistical tables* can be used to establish confidence intervals on the estimate as a function of the sample size and the number of reenlistments realized. For example, if in a sample of size 10, one individual reenlisted, the estimate of the reenlistment propensity would be 0.10. A 95% confidence interval on that estimate ranges from a low of almost zero to a high of 0.47; the probability that the true propensity to reenlist is greater than 0.47 is 0.05. As the sample size increases the range of the confidence interval diminishes. Thus, if in a sample of 100, 10 reenlist the estimate of the reenlistment propensity is 0.10, but a 95% confidence interval on the true propensity would now range from 0.05 to 0.18. This natural variability of the data obscures the impact of the SRB when the estimate at each SRB level is considered in isolation. To highlight this effect, consider the subpopulation statistics shown in Figure 4-3 for Black, high school diploma graduates in grade E1-E3 with no dependents where the 95% confidence interval for each estimate is shown by brackets.

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*W. Dixon and F. Massey, Jr., Introduction to Statistical Analysis, McGraw-Hill, 1969.

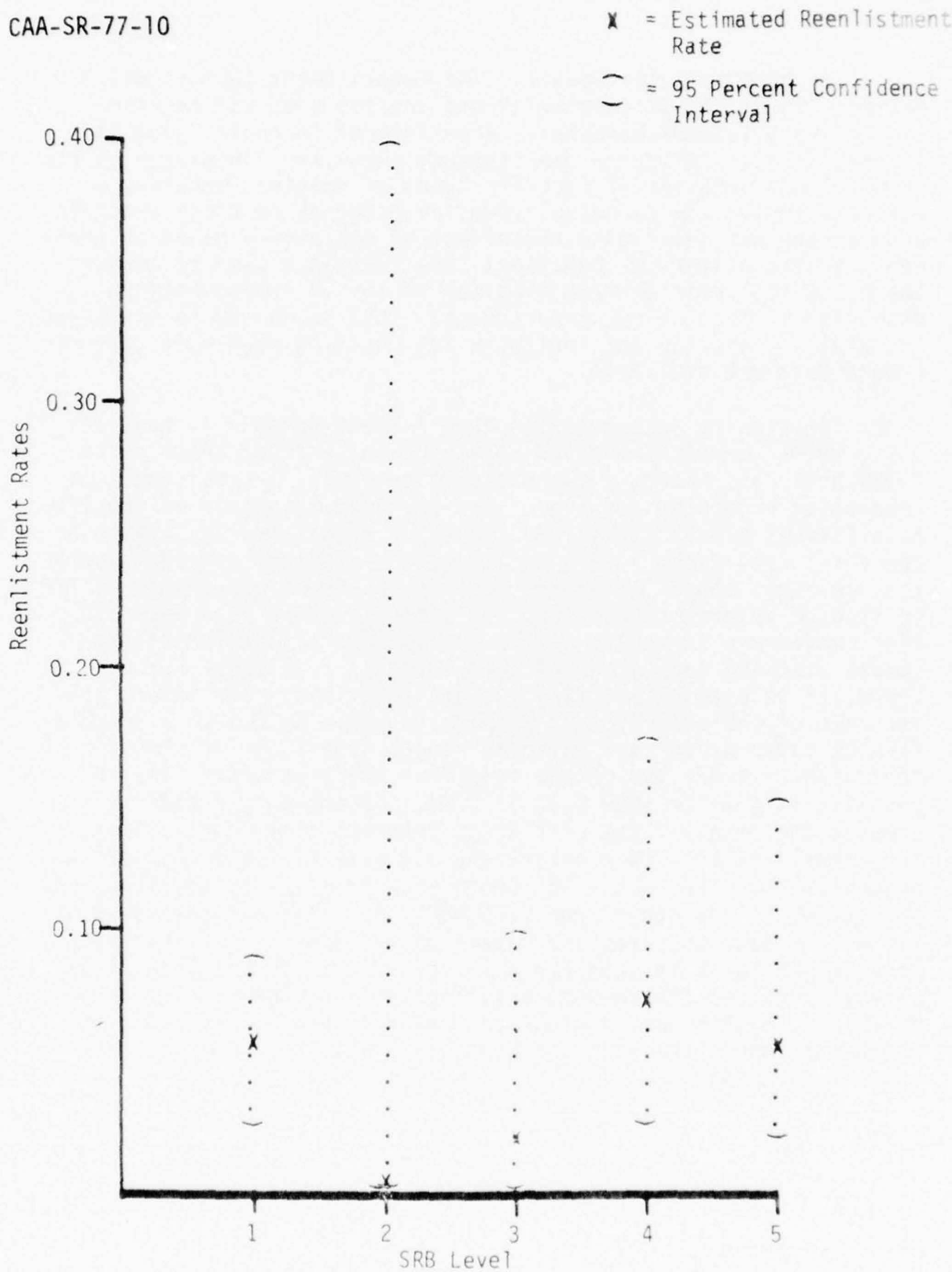

Figure 4-3. Raw Reenlistment Statistics with Confidence Intervals for Black, High School Diploma Graduates in Grades E1-E3 with no Dependents

(1) In Figure 4-3, the raw reenlistment rate is 7.3% at SRB 4 and 5.5% at SRB 5. The totals of this subpopulation at those SRB levels were, however, only 82 at SRB 4 and 73 at SRB 5. An increase of only two reenlistments at SRB 5 would have increased the SRB 5 reenlistment rate from 5.5% to 8.2%, thereby avoiding the apparent inconsistency of a lower reenlistment rate in return for a higher SRB level. The 32 subpopulations in Appendix E could be consolidated into more generally defined populations by eliminating one or more of the four reenlistment variables. With fewer subpopulations, the subpopulation size would be increased and the sensitivity of the reenlistment rate to small populations avoided. This approach, however, was rejected because there was no basis for assuming that small populations would remain constant between cohort files. A reduction in the number of subpopulations was also rejected because of the strong statistical significance that the variables of race, pay grade, education and number of dependents displayed in the AID III analysis. Accordingly, weighted linear regression was used to establish a relationship between reenlistment rates and SRB levels for all 32 subpopulations. The problem of potentially wide variation in reenlistment rates for small subpopulations was addressed by creating a joint probability distribution for use with subpopulations of less than 100 records at more than two SRB levels. These techniques are discussed in paragraphs (1) and (2) below.

(2) Weighted Linear Regression. This technique establishes a trend or regression line by weighting the observed reenlistment quantity at each SRB level according to its proportion to the entire subpopulation. In this manner, a population of 100 at SRB 2 would influence the regression line less than a population of 500 at SRB 3. By weighting each of the SRB data points according to the size of its SRB population, the regression line on reenlistment trend is not biased by disproportionately small SRB distributions (e.g., SRB 2 with only 512 error-free records). Figure 4-4 illustrates the use of this technique for the subpopulation defined as: White/other; no dependents; E-4 or above; non-high school graduate. The population size at each SRB level is shown in parenthesis. In Figure 4-4, the regression line is expressed as:

$$Y = 0.124 + 0.024X$$

where: X is the SRB level and Y is the reenlistment rate.

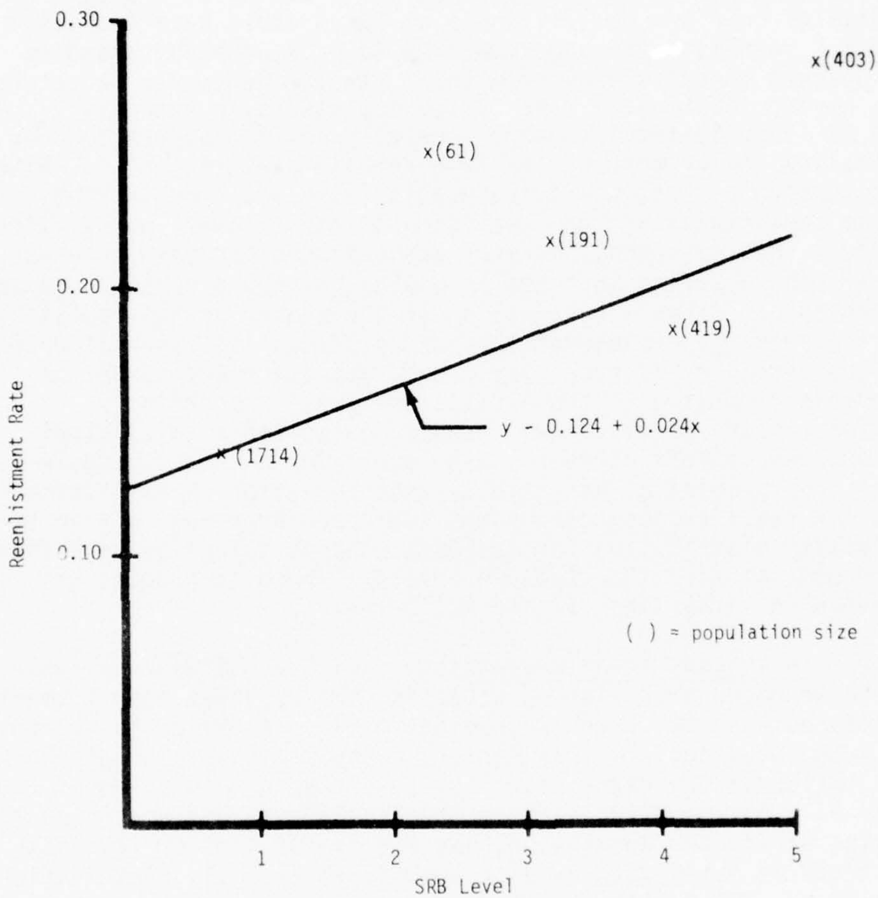

Figure 4-4. Reenlistment Behavior of White and Other, Non-high School Graduates, with no Dependents and in Grade E4 or Above

(a) This regression equation accounts for 77 percent of the variability of the weighted data and based on the sample of weighted data, the 77 percent is statistically significant at the 0.05 level (95% confidence). Because all members of the FY 71 cohort were offered a minimum reenlistment bonus (SRB 1), this equation is not statistically valid for populations which are not offered any bonus (SRB 0). Reenlistment estimates for SRB 0 populations would have to be developed from more current data. As an interim, the intercepts of the regression lines based on FY 71 data are considered reasonable approximations.

(b) Although weighted regression equations are suitable for estimating reenlistment rates for large samples, the degree of precision is sharply reduced when all or most of the SRB levels of a subpopulation are small. The example of Figure 4-3 illustrated the variability of small samples with associated broad confidence intervals. For this reason, the use of weighted linear regression on the raw data was restricted to those subpopulations with sample sizes of 100 or more within at least three of the SRB levels.

(3) The Joint Probability Distribution for Small Samples. The AID Model identified the variables most important in predicting reenlistment; the influence of these variables is verified by considering the separate or marginal significance of each of those variables as predictors of reenlistment. Figures 4-5 through Figure 4-8 show the raw data and weighted regressions for each of those variables when the subpopulations are defined in terms of only one variable. These weighted regressions conform to the limitations (subpopulations equal or greater than 100) discussed in the preceding paragraph.

(a) In Figures 4-5 to 4-8, the r^2 values validate the importance of each of the variables as separate predictors of reenlistment. The individual significance of each of the variables appears to justify rolling up small populations on one variable and basing the prediction of future effects on that variable. This would be a valid technique if the demographic characteristics of the populations remained constant, but the demography of the Army has and will continue to change. For example, consider pay grade as a predictor variable. In Figure 4-6 at SRB 4, a reenlistment rate of 16.8% is expected for E4's and above and a reenlistment rate of 3.6% is anticipated for E1-E3's. At the same time, Figure 4-5 indicates that Blacks at the same SRB level will reenlist at the rate of 27.8% while other races will reenlist at a rate of 13%. The percentage of Blacks in the Army has increased since FY 71 and, according to the racial behavior data, will have a reenlistment rate twice as high as other races at the SRB 4 level. If the ratio of E4 and above to E1-E3 has remained constant, then any prediction based on pay grade discounts the known effects of race. Similarly, if education and the number of dependents are valid predictors, the efficiency of those predictors is contingent on the other important attributes of the population at the time the estimating relationship was developed.

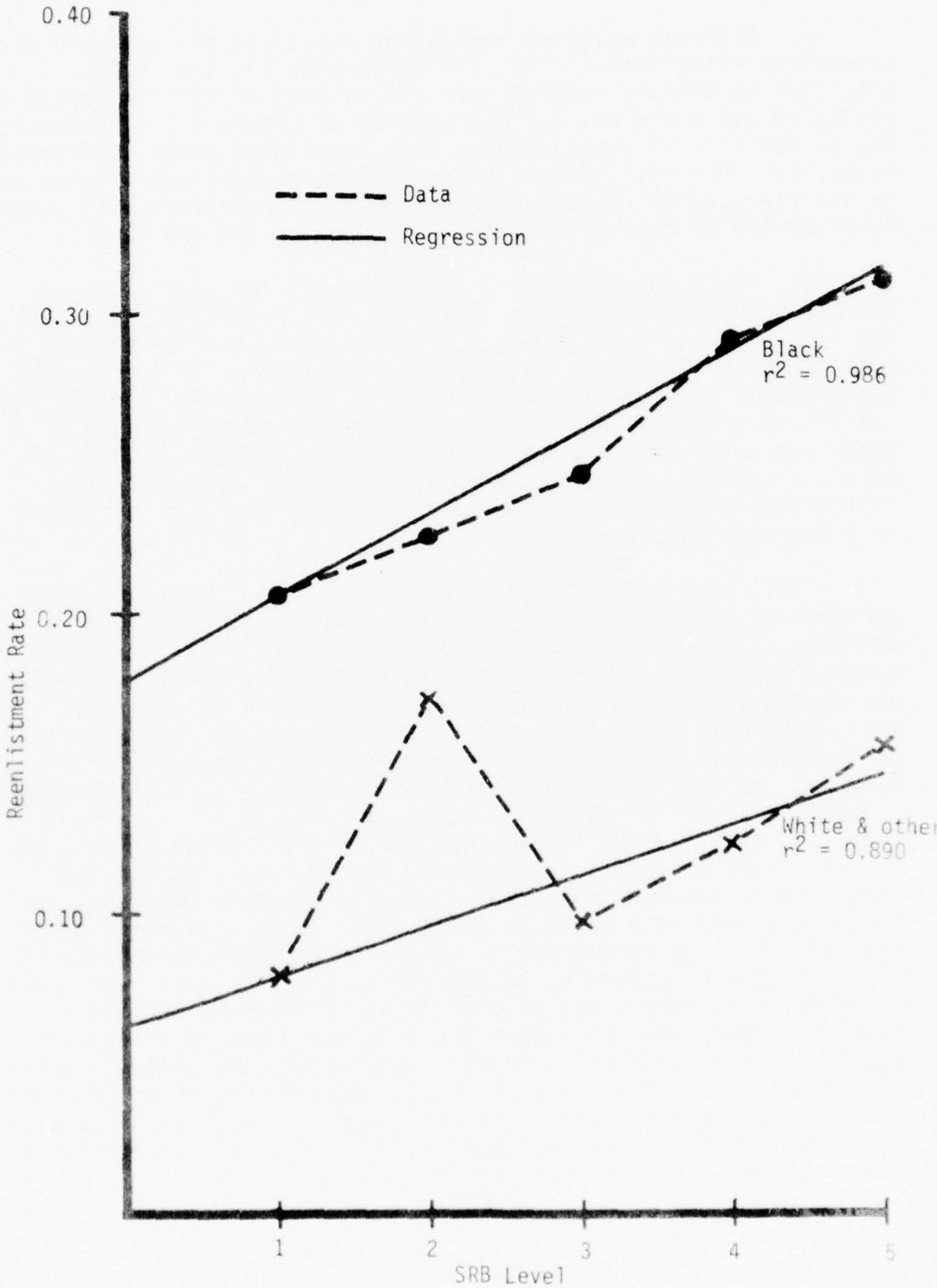

Figure 4-5. FY 71 Cohort Reenlistment Behavior by Race

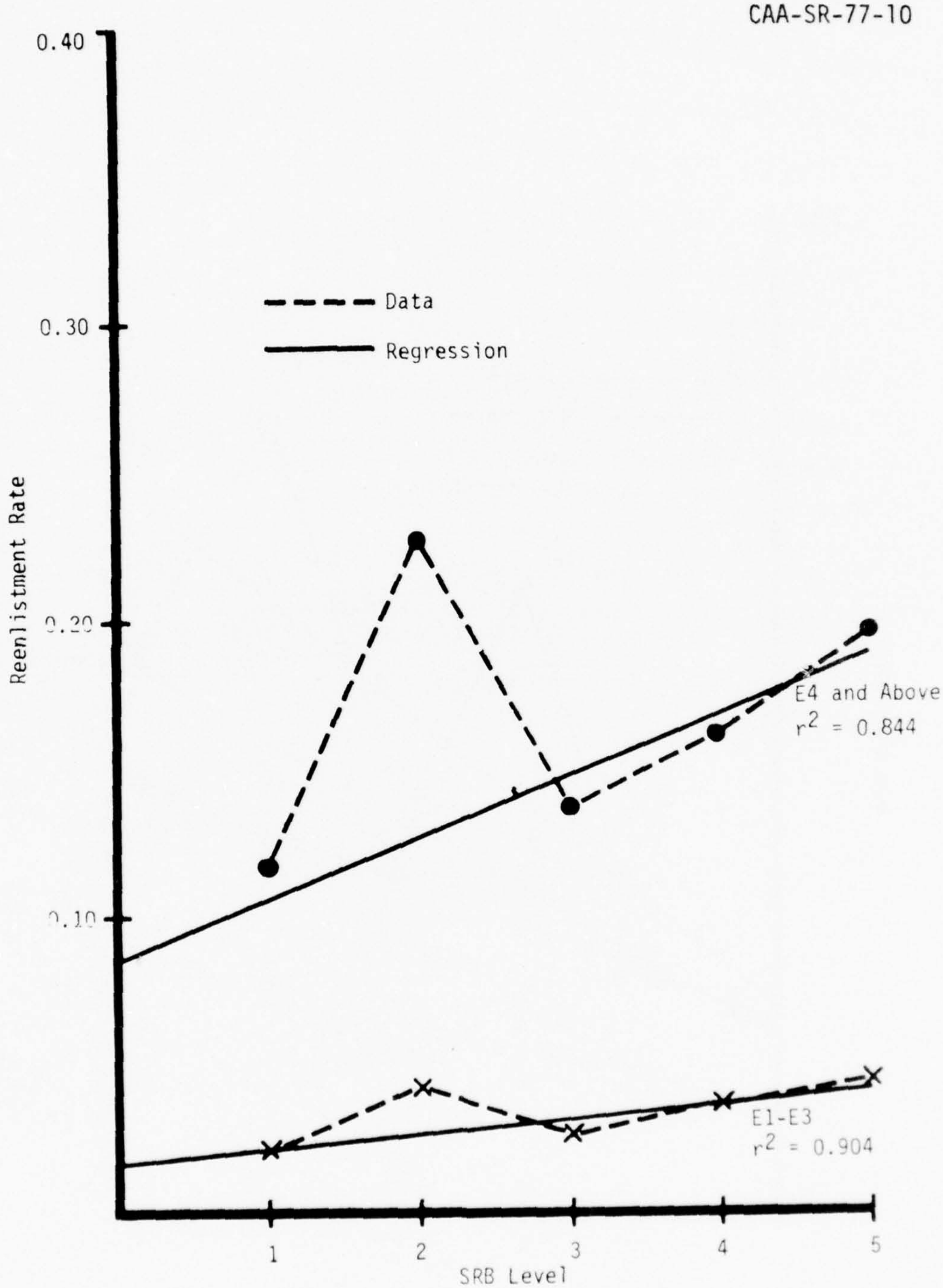

Figure 4-6. Reenlistment Behavior by Pay Grade

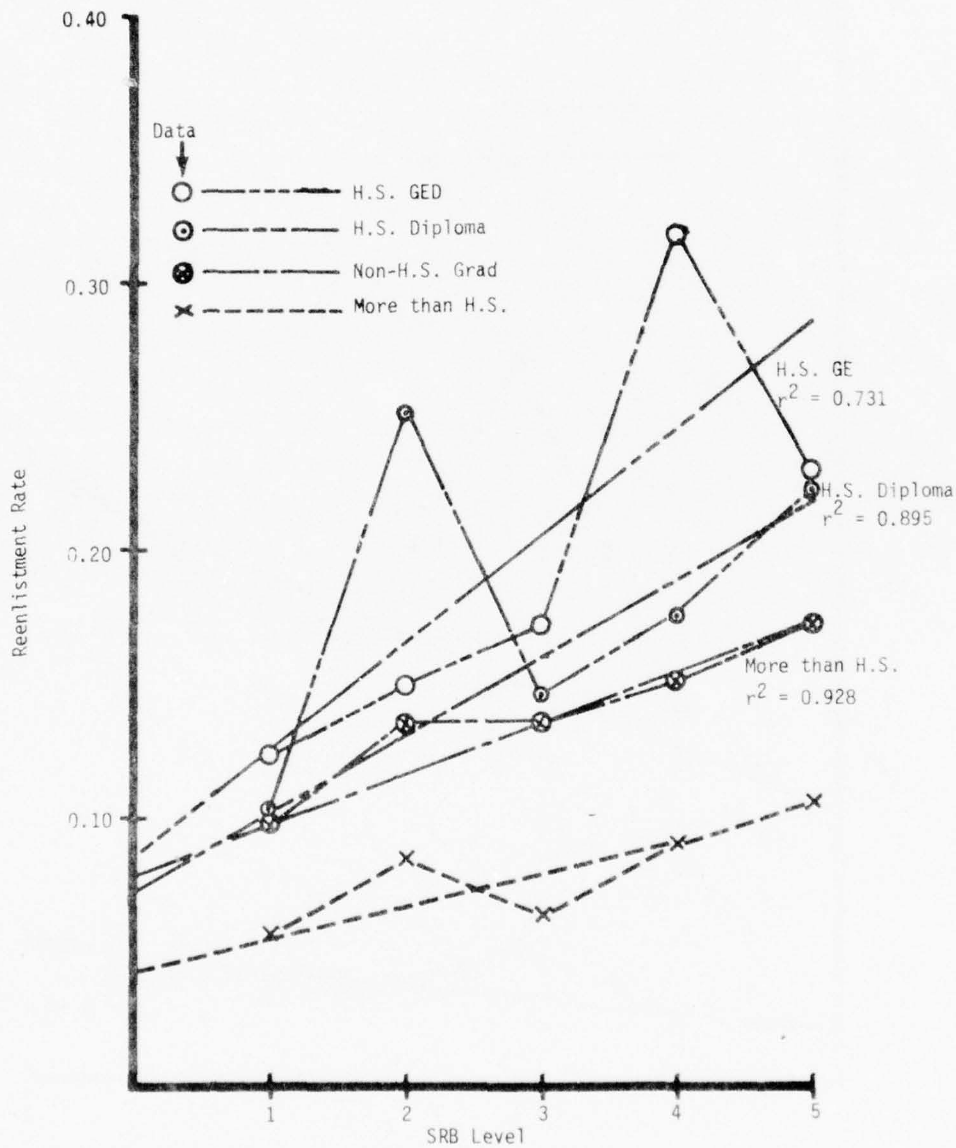

Figure 4-7. FY 71 Cohort Reenlistment Behavior by Educational Level

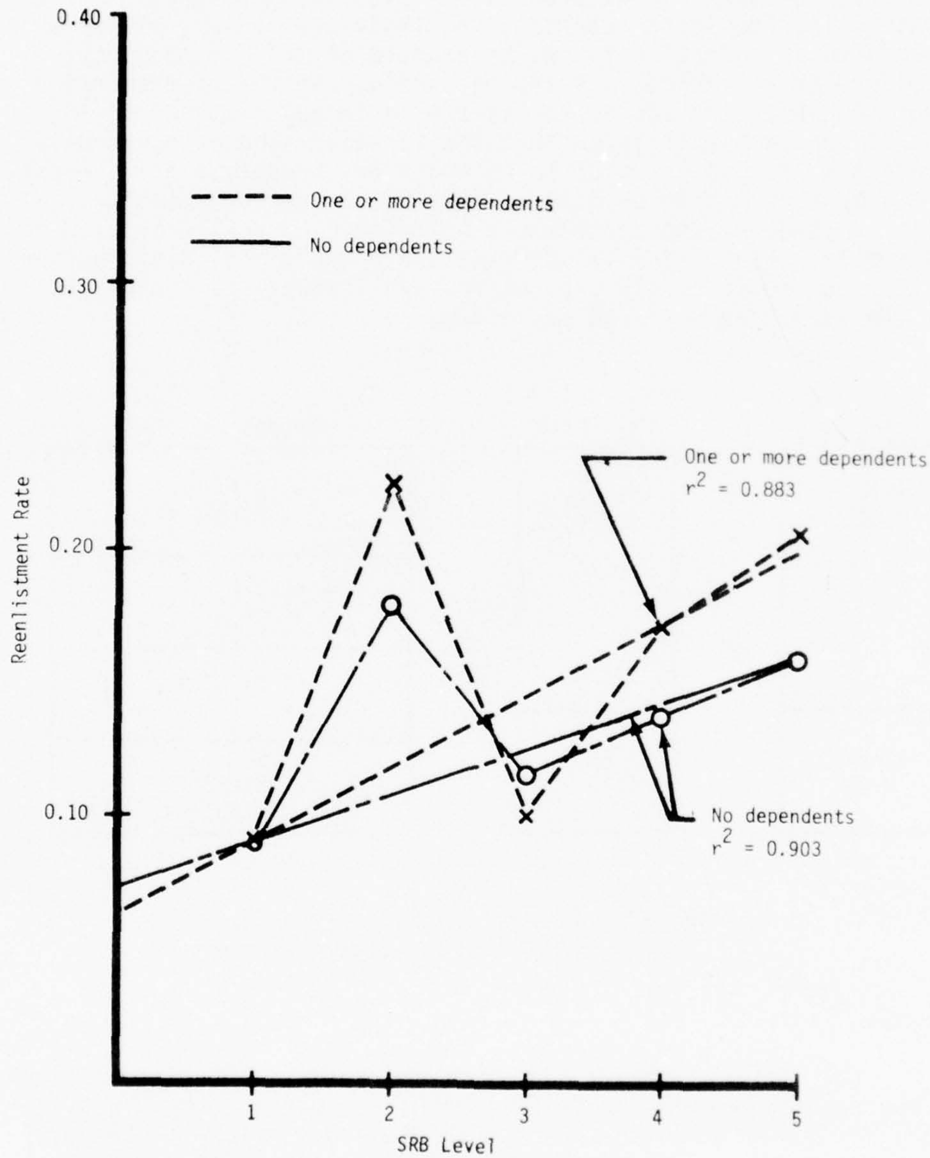

Figure 4-8. FY 71 Cohort Reenlistment Behavior by Dependent Status

(b) To compensate for the interaction between predictor variables, their marginal distributions within the FY 71 cohort were used to form a joint probability distribution function. In constructing the joint function, the individual predictors were assumed to be independent. As an example of this methodology, consider the variables race and pay grade. If 60% of the entire sample is White and 30% of the sample is in pay grade E1 to E3, then it can be hypothesized that the variable subpopulation defined as White, in grade E1 to E3 would be, proportionally, represented by 0.60 x 0.30 or 0.18 of the entire sample. Similarly, White in grade E4 and above would comprise 0.60 x 0.70 or 0.42 of the sample. Figure 4-9 illustrates the proportional distribution of the four collectively exhaustive reenlistment subpopulations for the variables race and pay grade.

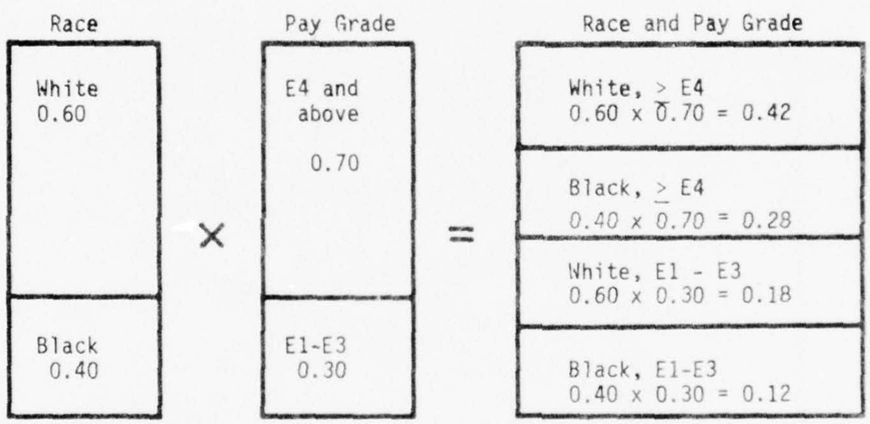

Figure 4-9. Proportional Distribution of Reenlistment Subpopulations

(c) Note in Figure 4-9 that the ratios of White to Black in the race/pay grade sample (0.42 + 0.18 = 0.60; to 0.28 + 0.12 = 0.40) are maintained for the race sample and similarily, the pay grade ratios are maintained (0.42 + 0.28 = 0.70, 0.18 + 0.12 = 0.30). Based on the principle of proportionality, it is possible to estimate reenlistment rates for small populations by scaling the reenlistment rates of one of the variables according to the reenlistment distribution of the other variable. To continue the previous example, suppose that the sample size is 1,000 and that the marginal reenlistment rates are as shown in Table 4-3.

Table 4-3. Illustrative Marginal Reenlistment Rates and Subpopulation Sizes

Variable	Subpopulation	Marginal Reenlistment Rate	Number of Reenlistees
White	600	0.10	60
Black	400	0.20	80
Total	1000		140
E1-E3	300	0.12	35
E4 and above	700	0.15	105
Total	1000		140

(d) In Table 4-3, both race and pay grade estimate 140 reenlistees from the sample of 1,000. In constructing the joint distribution it is assumed that reenlistment by race will occur at the rates calculated for pay grades except for constants of proportionality representing the effects of race. For the sample size of 1,000, the results of Figure 4-9 indicate that of the 600 Whites, 420 would be in pay grades E4 or above and 180 in pay grades E1 to E3. The constant of proportionality for Whites, C_w, can be derived by solving the following equation:

$$(420)(0.15)\,C_w + (180)(0.12)C_w = 60$$
$$84\,C_w = 60$$
$$C_w = 0.714$$

This constant is then used to compute a reenlistment rate of 10% (0.714 x 0.15) for Whites in grade E4 and above and 8.6% (0.714 x 0.12) for Whites in grades E1-E3. For Blacks, the constant of proportionality is: $(280)\,(0.25)\,C_b + (120)\,(0.12)\,C_b = 80$, $C_b = 1.418$. Using a $C_b = 1.418$ for Blacks, a rate of 21.3% is computed for E4 and above and a rate of 17.0% is obtained for grades E1-E3. Table 4-4 shows the results of these calculations for the example.

Table 4-4. The Joint Reenlistment Distribution

Variable	Subpopulation	Reenlistment Rate	Number of Reenlistees
White, E4 and above	420	0.107	45
White, E1-E3	180	0.086	15
Sub total	600		60
Black, E4 and above	280	0.213	60
Black, E1-E3	120	0.170	20
Sub total	400		80
Total	1000		140

(e) In Table 4-4, note that summing over race yields the marginal distributions by pay grade shown in Table 4-3 and that summing over pay grade yields the appropriate marginals by race. The use of this technique provides an estimate of reenlistment propensities for those samples too small for direct estimation. Weighted linear regression was then used to establish regression equations for these reenlistment estimates.

4-4. ANALYSIS OF REENLISTMENT FACTORS. Using the regression equations developed from the actual reenlistment data (for large populations) and from the estimates derived through joint probability distributions (for small population), reenlistment rates for the 32 subpopulations at each SRB level were computed. These reenlistment rates are shown in Table 4-5; the table is in two parts: A and B. The following paragraphs analyze the interaction of the four retention factors: race, education, dependents and pay grade on reenlistment and the SRB. To facilitate discussion, each of the 32 subpopulations have been sequentially numbered in each table and suffixed with a letter to denote the table from which it was taken. Subpopulation 8A, for example, refers to soldiers who are White/other; E1-E3; w/dependents; greater than high school education. Subpopulation 8B is the same except these soldiers are Black.

Table 4-5 (Part A). SRB Reenlistment Rates for FY 71 Cohort (White & Others)

Subpopulation: Non Highschool	Highschool Diploma	GED Highschool	More than Highschool	No Dependents	Dependents	E1 to E3	E4 or above	White and other	Black	Reenlistment Rate: SRB1	SRB2	SRB3	SRB4	SRB5	r^2	Number
X				X		X		X		.020	.024	.028	.032	.036	.9635	1A
	X			X		X		X		.022	.029	.036	.043	.050	.8713	2A
		X		X		X		X		.026	.034	.042	.050	.058	.7727	3A
			X	X		X		X		.012	.015	.018	.021	.024	.8826	4A
X					X	X		X		.020	.027	.034	.041	.048	.9089	5A
	X				X	X		X		.021	.031	.041	.051	.061	.8416	6A
		X			X	X		X		.026	.038	.050	.062	.074	.7822	7A
			X		X	X		X		.011	.015	.019	.023	.027	.8457	8A
X				X			X	X		.148	.172	.196	.220	.244	.7761	9A*
	X			X			X	X		.102	.128	.154	.180	.206	.8410	10A*
		X		X			X	X		.143	.174	.205	.236	.267	.7526	11A*
			X	X			X	X		.051	.061	.071	.081	.091	.9211	12A*
X					X		X	X		.146	.184	.222	.260	.298	.8583	13A*
	X				X		X	X		.143	.188	.233	.278	.323	.8391	14A*
		X			X		X	X		.142	.190	.238	.286	.334	.7765	15A
			X		X		X	X		.043	.062	.081	.100	.119	.7644	16A*

*Weighted linear regression on raw data

Table 4-5 (Part B). SRB Reenlistment Rates for FY 71 Cohort (Black)

Subpopulation: Non Highschool	Highschool Diploma	GED Highschool	More than Highschool	No Dependents	Dependents	E1 to E3	E4 or above	White and other	Black	Reenlistment Rate: SRB1	SRB2	SRB3	SRB4	SRB5	r^2	Number
X				X		X			X	.054	.061	.068	.075	.082	.9526	1B
	X			X		X			X	.056	.068	.080	.092	.104	.9812	2B
		X		X		X			X	.070	.085	.100	.115	.130	.5778	3B
			X	X		X			X	.030	.034	.038	.042	.046	.9008	4B
X					X	X			X	.054	.067	.080	.093	.106	.9156	5B
	X				X	X			X	.055	.074	.093	.112	.131	.9216	6B
		X			X	X			X	.070	.094	.118	.142	.166	.6119	7B
			X		X	X			X	.031	.039	.047	.055	.063	.8347	8B
X				X			X		X	.284	.301	.318	.335	.352	.7120	9B
	X			X			X		X	.271	.318	.365	.412	.459	.9119	10B*
		X		X			X		X	.368	.418	.468	.518	.568	.4611	11B
			X	X			X		X	.254	.266	.278	.290	.302	.7337	12B*
X					X		X		X	.283	.324	.365	.406	.447	.9465	13B
	X				X		X		X	.293	.362	.431	.500	.569	.9173	14B
		X			X		X		X	.368	.455	.542	.629	.716	.5964	15B
			X		X		X		X	.162	.188	.214	.240	.266	.8177	16B

*Weighted linear regression on raw data.

a. Race. The reenlistment rates for all 16 Black subpopulations (Table 4-5, Part B) are significantly higher than their 16 White counterpart populations (Table 4-5 Part A). This difference is also reflected in the higher overall Black marginal response (Part B) to the SRB when compared to the lower White marginal response (Part A). The Black marginal response to the SRB is consistent with a higher reenlistment propensity; it is logical that a subpopulation with a high reenlistment propensity at a low bonus level is more likely to have that propensity reinforced by an increase in the bonus. In spite of the marked difference between the overall Black and White reenlistment rates, the marginal response to the SRB of the 16 Black populations generally paralleled the White counterpart marginal response to the SRB. In this manner, subpopulations 4A and 4B had the lowest marginal response to an SRB and subpopulations 15A and 15B had the highest marginal response to the SRB. The parallel effects of reenlistment behavior and bonus marginal response are illustrated in Figure 4-10. These parallel effects not only show the significance of race as a retention factor but also serve to highlight the importance of the remaining retention factors (pay grade, number of dependents and educational level) in describing complete reenlistment/bonus behavior.

b. Education. The General Educational Development (GED) subpopulations showed high reenlistment propensity and high response to the bonus. At the opposite end of the reenlistment/bonus response spectrum were those soldiers who had educational achievements greater than high school. The indifference to reenlistment and bonuses displayed by soldiers who had high educational achievements may well be a shared perception that civilian opportunities resulting from their educational achievements are greater than military opportunities. The high reenlistment rates exhibited by the GED subpopulations may reflect an attitude that the GED equivalence has provided them with an increased opportunity to compete with the high school diploma graduate within the Army rather than within civilian occupations. The GED subpopulations may also be highly-motivated, non-high school graduates who perceive that the GED equivalence will enhance their military opportunities. The distinction between non-high school graduates and high school diploma graduates is less clear. High school graduates reenlist at a higher rate (an exception is subpopulation 9A: Whites; E4 or above; non-high school graduate; no dependents) and are more responsive to the bonus than soldiers without a high school diploma. This distinction, however, is less pronounced between soldiers in grades E1-E3. The reenlistment behavior of the high school graduate unquestionably has some bias resulting from Army policy which favors soldiers having a high school diploma or GED equivalence. This preference, however, does not account for the higher marginal response to the SRB demonstrated by the high school diploma graduate.

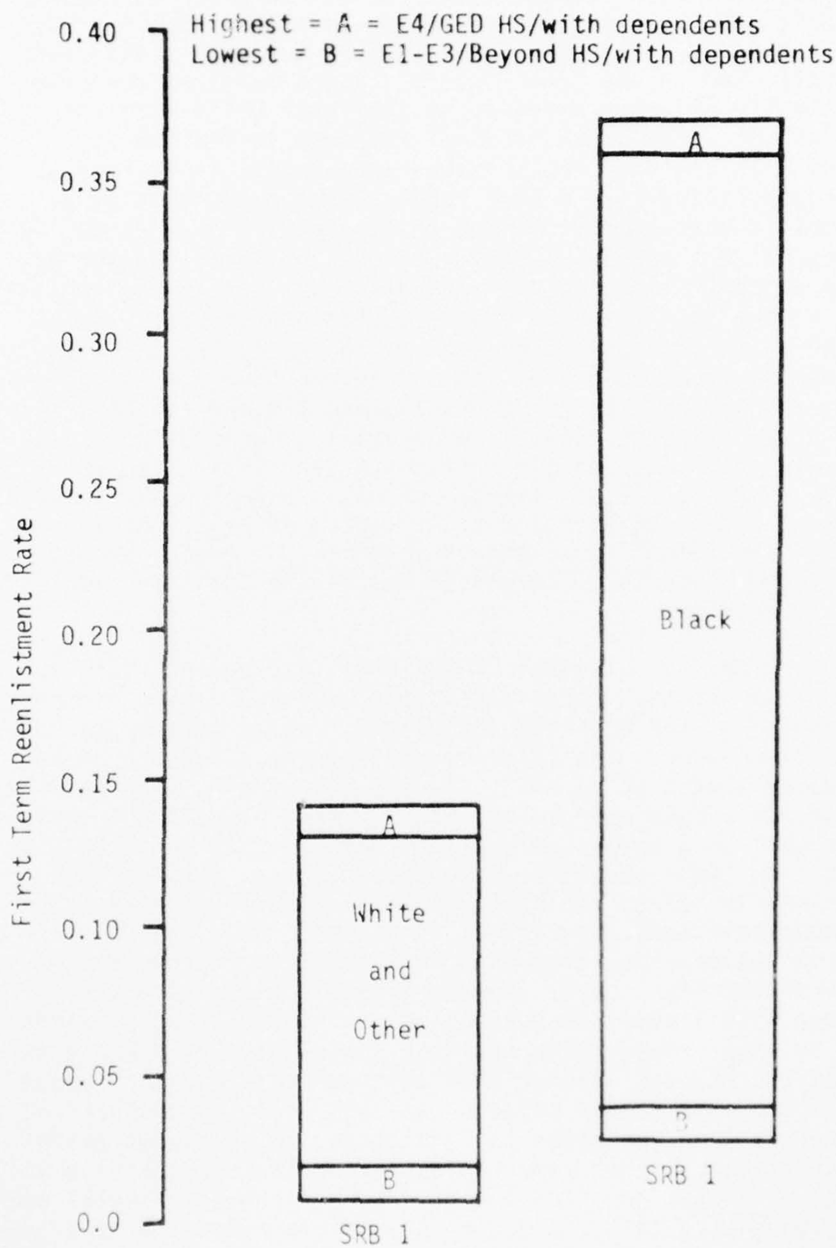

Figure 4-10. The Range of Subpopulation Reenlistment Rates for The FY 71 Cohort at SRB 1

c. Dependents. At an SRB 1, soldiers with dependents display little difference in reenlistment rates from those without dependents; exceptions to this general rule are Black and White, E4 or above, with more than a high school education and without dependents (subpopulations 12A and 12B) who reenlist for an SRB 1 at a slightly higher rate than their married Black or White counterparts (subpopulations 16A and 16B). These exceptions may reflect the perceived need on the part of the highly educated soldier with dependents for higher pay consistent with his education and his family responsibilities. As the SRB level is increased, however, family obligations appear to exert more influence. This perception is reinforced by the significantly higher marginal response to the higher SRB levels displayed by all soldiers with dependents than those without dependents. The soldier with dependents is apparently more likely to be induced by a higher bonus than his counterpart without dependents because the bonus offers increased family support without the uncertainity of seeking new employment.

d. Pay Grade. Soldiers in pay grade E4 or above demonstrate a decidedly higher reenlistment propensity and marginal response to the SRB than their counterparts in grades E1-E3. The high reenlistment propensity at the SRB 1 level is reinforced at the higher SRB levels. This higher reenlistment response to an SRB is possibly due to the positive reinforcement that "successful" soldiers receive from military service (as demonstrated by their higher grade). Conversely, those soldiers in the lower grades may be displaying an indifference to the service by failing to compete successfully. This indifference to reenlist even at high bonus levels is generally reciprocated by Army retention policies which may not encourage, or even prohibit, reenlistment of marginal performers.

4-5. SUMMARY. As discussed in the preceding paragraphs, there are general trends in reenlistment or SRB response which emerge when viewing the four retention factors (race, education, pay grade, and number of dependents) either in isolation or in concert. The difference in specific reenlistment rates and SRB marginal responses between the 32 subpopulations identified in this chapter indicate the need to maintain a multidimensional view of the soldier. Although the general statement that Blacks reenlist at a higher rate than Whites is supported by analysis of the FY 71 cohort data, this statement ignores the fact that certain Whites reenlist at higher rates than some Blacks. The four retention factors of race, education, number of dependents, and pay grade provide enough specific data to permit a better estimate of the kind of soldier the Army will attract with an incentive policy and where, if possible, to focus that retention policy. The ability to focus on the "whole man" in formulating retention policy also has a corollary in recruiting efforts and in-service policies such as promotion, education, and dependent care and welfare.

NOT USED

CHAPTER 5

BONUS ALTERNATIVES

5-1. INTRODUCTION. In Chapter 4, reenlistment factors were developed and used to derive reenlistment rates for first term soldiers. These rates differed from tabulated statistical data because these rates defined specific soldier subpopulations in a manner that explained or told "who" was reenlisting. The historical reenlistment behavior of these soldier populations was then correlated with the five SRB levels which permitted inferences concerning the effect of the SRB; who responded to each SRB level and who did not? By quantifying the effects of the SRB in this manner, these effects could be used as input to the CEABREP system and used to provide a bonus manager with more detailed projections of the impact of the SRB on the enlisted force. In the same manner, the historical effects of other policy incentives can be assessed, quantified and used within the CEABREP system to estimate their effect on the projected force. Implicit in this approach, is the requirement for historical data which spans the policy under consideration and from which the historical effects can be derived. As discussed in Chapter 1, the effects on reenlistment rates of incentive policies as alternatives for the SRB could not be quantified because of current Army personnel data limitations. Notwithstanding this impediment, a stated objective of this study requires the exploration of alternatives to high SRB payments. This chapter, within the constraint of the data limitations, discusses two alternatives to the SRB. These alternatives are induced MOS reclassification and the CONUS-to-CONUS station of choice reenlistment option. The following discussions are based on the rationale that reenlistment incentives that cost no more than an SRB, and are acceptable to a soldier in lieu of an SRB, are viable bonus alternatives.

5-2. INDUCED RECLASSIFICATION. While the Army currently permits soldiers in surplus MOS to reenlist for shortage MOS (if mentally and physically qualified), existing regulations provide little incentive for these soldiers to do so, even if the shortage MOS has a bonus entitlement. Current regulations require a soldier to hold an MOS for 90 days prior to reenlistment to be eligible to receive a bonus in that MOS; yet in most cases, for a soldier changing his specialty (reclassification), the new MOS cannot be awarded until after the soldier has reenlisted for it. Although a shortage MOS may be authorized a selective reenlistment bonus level 5 (SRB 5) and a surplus MOS authorized no bonus (SRB 0), the soldier in the surplus MOS cannot be paid a bonus for reenlistment in either the surplus or the shortage MOS. There is no positive

inducement for the soldiers in surplus MOS (who are mentally and physically qualified for a shortage MOS) to move from the relative security of their current MOS to the unknown environment of the shortage MOS.

a. Marginal Cost. A reenlistment incentive does not need to be focused entirely on the reenlistment decision of soldiers in a shortage MOS. As discussed in the analysis of retention factors (see Chapter 4), each SRB increase within an MOS focuses on a smaller residual population that is more "bonus resistant" or is less career-motivated. Concurrently, the SRB increase "over sells" the MOS to those soldiers who were motivated to reenlist without a bonus or at a lower bonus level. To illustrate this effect, consider a notional MOS with a population representative of the FY 71 accession cohort. Table 5-1 shows the expected reenlistment rates and both the direct and marginal costs per reenlistee.

Table 5-1. Representative Reenlistment Rates and Costs

SRB Level	Reenlistment	Cost per Reenlistee[a]	Marginal Cost per Reenlistee
1	9.2 percent	$2,380	--
2	11.0 percent	4,625	$16,099
3	12.8 percent	7,150	22,581
4	14.6 percent	9,020	22,317
5	16.4 percent	10,695	24,281

[a]Source: Monetary Incentives Management Branch, EPD, MILPERCEN

(1) In Table 5-1, a reenlistment rate of 9.2% is expected for an SRB 1 and this rate would increase to 11.0% at SRB 2; it may be inferred that included in the 11% at SRB 2 are the 9.2% who would have reenlisted at the SRB 1 level. This inference is based on the premise that a soldier who is willing to reenlist for a low bonus will also reenlist at a higher bonus level.

The marginal costs shown in Table 5-1 are developed from the following equation:

$$\text{Marginal cost} = \frac{(C_{n+1}\ R_{n+1} - C_n\ R_n)}{(R_{n+1} - R_n)}$$

Where C equals the bonus cost per reenlistee at bonus level n and R equals the reenlistment rate expected at bonus level n. Using the reenlistment rates and cost per reenlistee shown in Table 5-1 the marginal cost per reenlistee of changing SRB 1 to SRB 2 is calculated:

$$\text{Marginal cost} = \frac{\$4625 \times 0.11 - \$2380 \times 0.092}{0.11 - 0.092}$$

$$\text{Marginal cost} = \frac{\$508.75 - \$218.96}{0.018}$$

$$\text{Marginal cost} = \$16{,}099.$$

An increase of the SRB level from 1 to 2 therefore results in a marginal cost of $16,099 per additional reenlistee. The high marginal cost of providing additional reenlistees through bonus increases might be reduced by offering small bonuses to induce career-motivated soldiers to reclassify from surplus to shortage MOS. Used in this manner, the bonus is redirecting existing reenlistment potential rather than attempting to create it within a limited and reluctant audience. Furthermore, every bonus payment used to induce reclassification contributes to the resolution of a surplus problem as well as a shortage problem. Because the bonus would be paid only to soldiers who voluntarily reclassify, the high marginal cost encountered by increasing the SRB level is reduced. Figure 5-1 compares the cost of inducing reclassification by using an SRB 1 compared to the cost of increasing reenlistments through higher SRB payments.

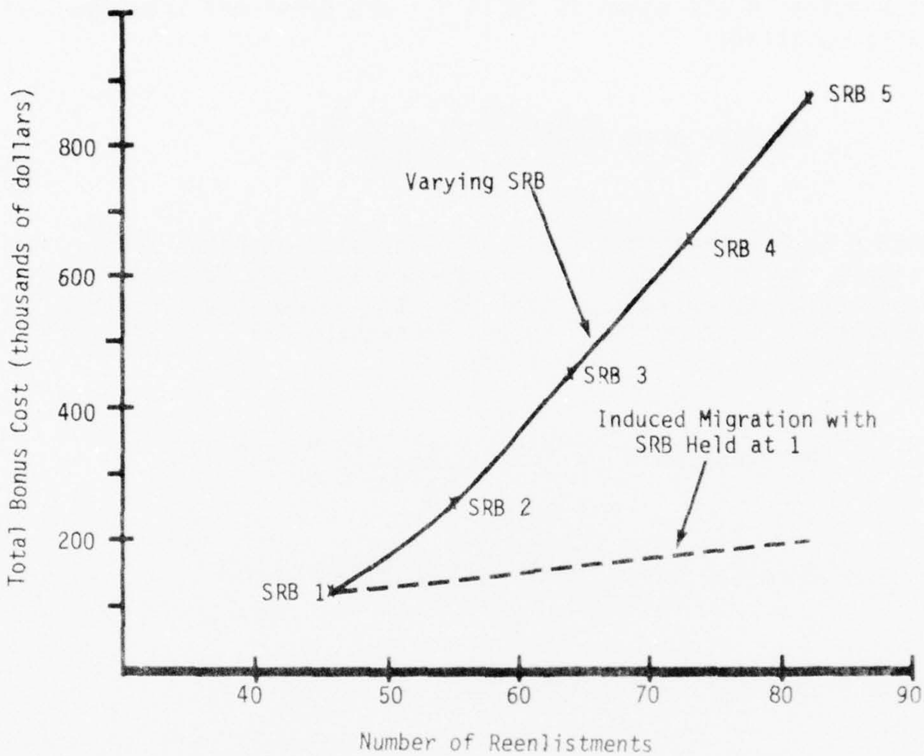

Figure 5-1. Cost Comparison between Induced Migration and SRB Increases

(2) The curves in Figure 5-1 are based on the data of Table 5-1. The marginal cost for each reclassification is equal to the SRB 1 cost because the SRB would be paid only to those soldiers who reclassify. The marginal cost for increasing the SRB level for those already qualified in the MOS is as shown in Table 5-1. If the shortage MOS required no additional training, the cost avoidance as a result of reclassification is the difference between the curves. If training is required, then the inducement SRB plus the variable cost of training must be less than the marginal cost of increasing the SRB within the MOS to justify the inducement bonus on a strict cost avoidance basis. There are, however, circumstances when it may be inappropriate to include training costs in calculating the true cost avoidance. The Army currently permits potential reenlistees to reenlist for any other MOS which is either balanced or short. This option is actively supported by MILPERCEN to encourage flow from surplus MOS, but as currently administered, MILPERCEN cannot influence the flow into

the MOS most seriously short. MOS managers are willing to incur additional training costs at reenlistment as a general reenlistment incentive and manage the program only in terms of reducing the strength of surplus MOS; from this viewpoint, training costs could be regarded as sunk costs and the cost differential of Figure 5-1 can be applied as the true cost savings of induced reenlistment from surplus to the shortage MOS. If authorized, the inducement bonus should be restricted to permit flow only from surplus to shortage MOS. Reenlistment into a shortage MOS from balanced or other shortage MOS could continue under current policies, but the use of an inducement bonus for such reclassifications can not be considered cost effective and should probably be discouraged.

b. Advantages of an Inducement Bonus over Mandatory Reclassification. The Army, selectively, can deny reenlistment to soldiers in surplus MOS or mandatorily reclassify individuals within surplus MOS who have not completed their enlistment or reenlistment terms of service. Mandatory reclassification may be unavoidable when changes in the force structure create large and sudden MOS imbalance. Mandatory reclassification could be used in lieu of an inducement bonus; however, there is a potential for increased turbulence within the force as well as the negative effects on morale and efficiency of soldiers who are involuntarily reclassified. Figure 5-2 illustrates reclassification prior to reenlistment where individuals in surplus MOS A are involuntarily reclassified to a shortage MOS B, perhaps requiring additional training. Because the Army currently authorizes reenlistment from any MOS to any other MOS which is either balanced or short, the potential is high for those involuntarily reclassified to reenlist out of the shortage MOS and into a balanced MOS, in Figure 5-2, MOS C. The implication is that reclassification should take place after reenlistment when additional changes of MOS are not possible. Figure 5-3 shows the reclassification process taking place after reenlistment where again MOS A is surplus prior to reenlistment and MOS B is short. Currently, in managing the reenlistment process, MILPERCEN and the career counselers in the field encourage reenlistments out of the surplus MOS. In Figure 5-3 this flow is represented (solid line) as going to MOS C through MOS Z. When the reenlistment process is complete, the reclassification process (solid line) is then used to correct the shortfall in MOS B. The net flow after both reenlistment and reclassification may have been a flow from MOS A to MOS B, but because managers are unable to direct flow from the surplus MOS to the shortage MOS at the time of reenlistment, additional changes of MOS with resulting training are unavoidable. The option of an inducement bonus, as shown by the dotted lines in Figure 5-3, provides a means for influencing this flow at the time of reenlistment.

the marginal reenlistment rates are as shown in Table 4-3.

4-18

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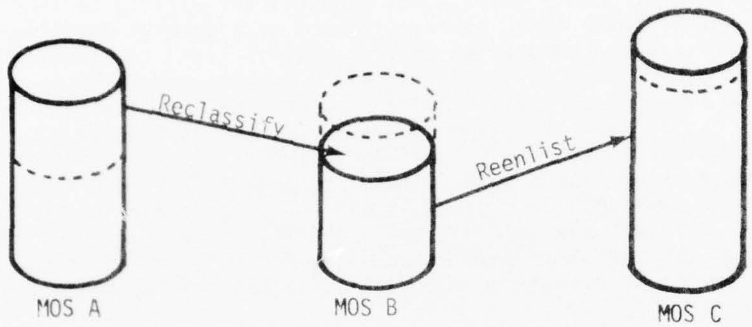

Figure 5-2. Reclassification Prior to Reenlistment

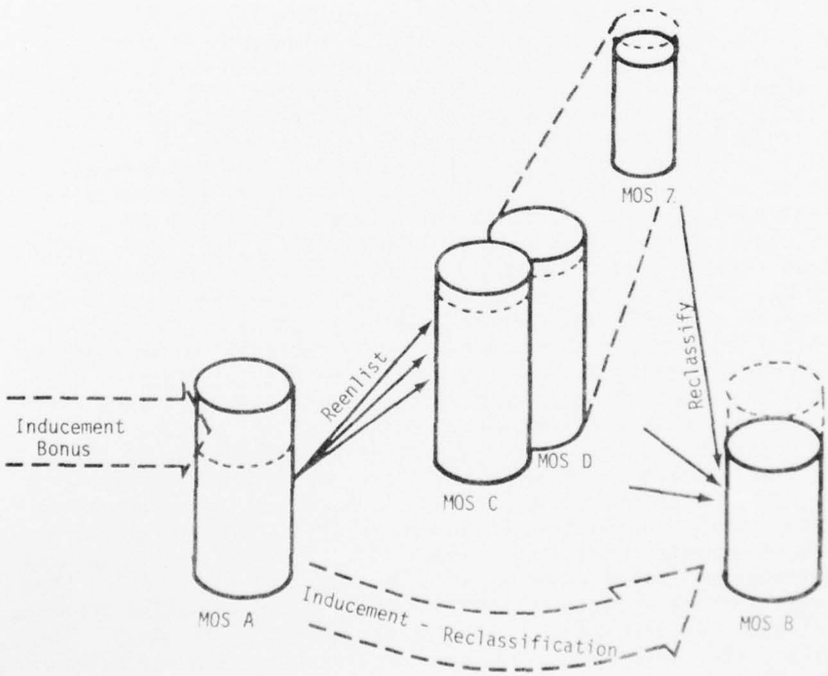

Figure 5-3. Reclassification After Reenlistment

c. Reclassification Training. The Army's current method of allocating school spaces gives priority to accessions and may preclude effective operation of an inducement bonus program. The required number of school spaces for an MOS is established based on a total projected shortfall (first term and career forces) in the MOS. These school spaces are entered into the Recruit Quota System (REQUEST),* for use by the Recruiting Command. The REQUEST System allows Army recruiters to reserve school spaces by name for accessions to the Army. Because of priority accorded to the accession program, some of these schools are fully subscribed by new accessions several months in advance, even though the justification for some of those spaces may have been predicated on the needs of the career force. The potential reenlistee in this case is effectively denied reenlistment in the shortage MOS because the Army is not capable of qualifying the individual in the new MOS within a reasonable time. There are currently no provisions to "fence" school spaces for the active Army. Before considering induced reclassification as an alternative to the SRB, the Army's policies on allocation of school spaces should be reviewed.

5-3. THE CONUS-TO-CONUS STATION OF CHOICE REENLISTMENT OPTION. This option was eliminated by the Army in April 1975, primarily to reduce the Army's requirement for permanent change of station (PCS) funds and to stabilize job assignments. While elimination of this option may have been successful in eliminating PCS obligations directly associated with this option, it may have resulted in increased accession costs and/or replaced the stabilization problem with a shortage problem.

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*Request System Guide July 1974, Enlisted Personnel Management Directorate, Enlisted Training Division (Request Project Office), MILPERCEN.

a. The effect of the Station of Choice Option. In Figure 5-4, Case I illustrates the station of choice reenlistment option. An individual assigned at "A" desired to reenlist for a vacancy at "B" as shown by the dotted line, and is permitted to do so resulting in two PCS moves shown by the solid lines; an operational PCS to move the individual from "A" to "B" and a PCS move (accession or operational) from some external source "S" to "A". Ideally, elimination of the station of choice option would result in Case II where the individual at "A", denied "B", would reenlist for his own vacancy resulting in only one PCS move--from "S" to "B". However, Case II is not the only possible outcome from elimination of this option. Case III results in three PCS moves when the individual at "A" refuses to reenlist at all--a separation PCS results and vacancies must be filled at both "A" and "B"; Attempts to quantify the effect of the CONUS-to-CONUS station of choice option were unsuccessful due to the lack of complete cohort files covering the period when the option was eliminated. Attempts to estimate the effect of the option from ODCSPER aggregated data were also unsuccessful because of multiple policy changes. At the end of March 1975, the CONUS-to-CONUS station of choice option was eliminated and the reenlistment eligibility zone simultaneously was changed from 21 months of service to within 90 days of Expiration of Term of Service (ETS). In mid-May 1975, reenlistment eligibility was restricted to 30 days prior to ETS for bonus recipients. Effective 1 July 75, 15 days lost time (e.g., absent without leave) constituted an unwaiverable bar to reenlistment. On 1 Aug 75, controls were imposed on the reenlistment of non-high school graduates and individuals who had scored less than 100 on MOS proficiency tests. The expectation was that these policies would depress the reenlistment rate. In March 1975, ODCSPER reported a Regular Army first term unadjusted reenlistment rate (reenlistments divided by total separations) of 55.8%; by June that rate had fallen to 17.3% and by September had reached a low of 10.6%.* The compound effects of the several personnel policy changes precluded isolation of the effect of eliminating the station of choice option. ODCSPER is currently planning to restore this option on a test basis under statistical control to determine the effect of the option on reenlistment propensities. This will permit a full comparison of this option with the SRB.

*ODCSPER Monthly Reenlistment Rate Reports, RCS DDM-850.

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COST EFFECTIVENESS ANALYSIS OF BONUSES AND REENLISTMENT POLICIE--ETC(U)

AUG 77 C M ANDERSON, A K HOLTRY, R PLOURDE

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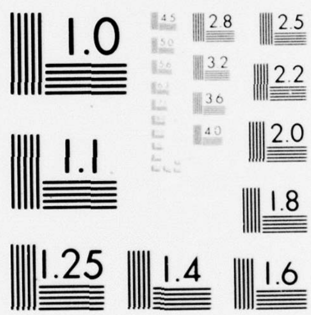

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

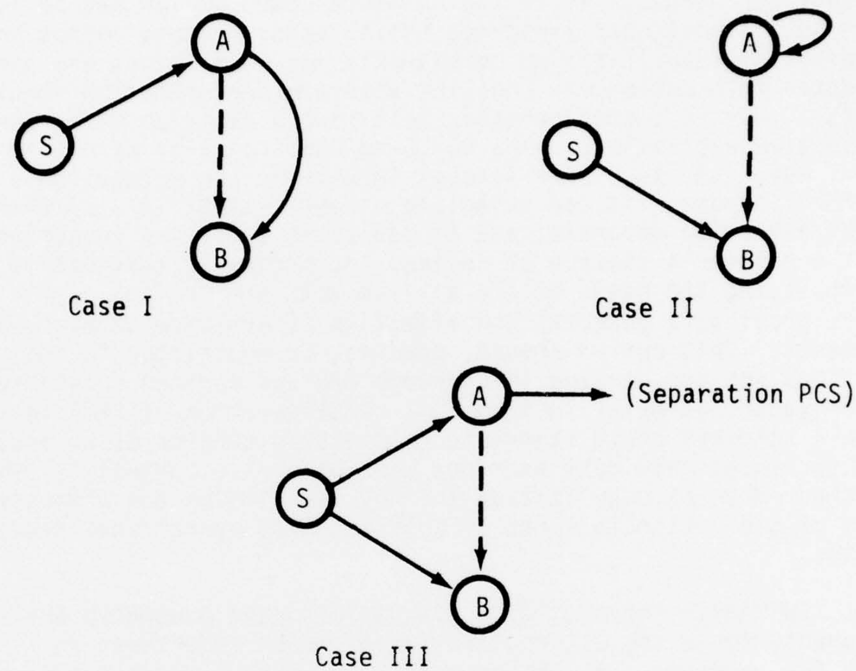

Figure 5-4. PCS Alternatives

b. Cost. The CONUS-to-CONUS station of choice option can be shown to be a cost effective alternative to the SRB even in the absence of specific data on the effect of the option. The Office of the Director of Plans, Programs and Budget, ODCSPER, currently estimates that a PCS within CONUS for an individual in grade E4 or E5 costs $120 without dependents and $909 with dependents. If an MOS is critically short at the SRB 1 level and an increase to SRB 2 is contemplated, the individuals in the MOS could be offered a choice of the SRB 2 or the SRB 1 with station of choice. From Table 5-1, the average SRB 1 costs $2380 per reenlistee. The SRB 1 payment plus the $909 PCS cost for an E4 or E5 totals $3,289 which is less than the average cost of $4,625 which would be paid at the SRB 2 level. By offering the potential reenlistee this choice of options (station of choice plus SRB 1, or an SRB 2 or higher), the Army is assured at least the reenlistment rate that would be achieved by simply raising the SRB level. For each individual who accepted the station of choice option at the reduced bonus level a net savings of $1,336 could be realized if the reenlistee had dependents and $2,125 could be saved for each reenlistee

without dependents. While the CONUS-to-CONUS option can be justified on a strict cost avoidance basis, other factors cannot be quantified. Stabilization commitments for reenlistees who have accepted this option may conflict with overseas rotation requirements. This is a consideration left to the decision maker for subjective evaluation. The CONUS-to-CONUS station of choice option, when used as a reenlistment incentive, can accomplish a twofold purpose: it can stimulate a reenlistment in a soldier who might otherwise separate; and it can serve to fill a requirement at the soldier's station of choice. Accordingly, this option, by synthesizing the needs of the service with the desires of the soldier, provides a powerful and effective alternative to high SRB payments. This option should, however, be restricted to those soldiers who are serving in shortage MOS and applied to stations where vacancies exist in that MOS. Proliferation of this policy to all soldiers could stimulate soldiers in surplus or balanced MOS to request new duty stations when otherwise content to remain at their present duty station thereby diminishing the effectiveness of the option in terms of cost and Army operational requirements.

5-4. SUMMARY. The preceding discussions have presented empirical arguments for using alternative reenlistment incentives in lieu of high SRB payments. At the present time, data limitations require that these assessments be substituted for quantified estimates of each policy's effect on reenlistment (see Appendix C). Empirically, induced reclassification and CONUS-to-CONUS station of choice option have been shown cost effective. These options can be used by the bonus manager as additional tools to influence reenlistment decisions. Induced reclassification redirects existing reenlistment potential within surplus MOS to shortage MOS. The CONUS-to-CONUS station of choice option, by substituting a geographical inducement for a monetary inducement, has the potential of attracting soldiers indifferent to monetary incentives. The demonstrated cost effectiveness and utility of these alternatives are, however, based on their use as a substitute for high SRB payments. Accordingly, like the SRB, these options should be used for resolving MOS imbalance. Non-selective use of these incentives could encourage soldiers to remain in surplus MOS or to leave balanced or short MOS; this would obviate the cost effectiveness of the alternatives.

CHAPTER 6

OBSERVATIONS

6-1. INTRODUCTION. The Cost Effectiveness Analysis of Bonuses and Reenlistment Polices (CEABREP) Study developed a methodology and system design for an automated system to enable bonus managers to assess the potential costs and effectiveness of bonuses and bonus policies. Portions of the CEABREP system were used to analyze and quantify factors which influenced the reelistment behavior of FY 71 accessions to the Army.

6-2. ESSENTIAL ELEMENTS OF ANALYSIS. The EEA specified in the tasking directive are discussed below.

a. What are the factors influencing reenlistment? Can this influence be quantified? The most important factors influencing the reenlistment behavior of FY 71 accessions were race, education, pay grade, and the number of dependents. Estimating relationships were derived to predict reenlistment as a function of these variables and the SRB. These estimating relationships are in Chapter 4, Development and Analysis of Reenlistment Factors.

b. Does the enlistment bonus, when used in conjunction with SRB, become a lower cost method of providing fill to an MOS? If so, what SRB level? This EEA could not be addressed during the study because of data limitations discussed in Chapter 1, Introduction, and Chapter 2, Methodology. Only the FY 71 cohort file was available and the enlistment bonus was not offered in FY 71.

c. Are there other cost alternatives that could be used in lieu of or in conjunction with the SRB to provide fill to MOS? Yes. Specific examples include restoration of the CONUS-to-CONUS station of choice reenlistment option and induced reclassification whereby soldiers in surplus MOS are encouraged to reenlist for shortage MOS. These alternatives were shown to be cost effective at the MOS level, but were not recommended as general reenlistment inducements. These alternatives are discussed in Chapter 5, Bonus Alternatives.

6-3. OBSERVATIONS. The major observations resulting from this study of the reenlistment process are as follows:

a. Reenlistment factors can be developed and quantified using historical reenlistment data. These factors can be used to provide a comprehensive view of reenlistment behavior. Observations relevant to three- and four-year enlistees of the FY 71 cohort are:

(1) The most significant variables as predictors of reenlistment behavior for FY 71 accessions were: race, education, pay grade and the number of dependents.

(2) The best single discriminator of reenlistment behavior is race. The Black racial group reenlisted at a rate approximately double the rate of Whites and Others at all SRB levels.

(3) Within the education category, General Education Development (GED) high school graduates exhibited the highest reenlistment rate and those with some education beyond high school demonstrated the lowest propensity to reenlist. At the SRB 1 level, high school diploma graduates reenlisted at a slightly higher rate than non-high school graduates; however, high school diploma graduates were influenced by increased bonus levels to a greater extent than non-high school graduates.

(4) Soldiers in pay grades E-4 and above consistently displayed higher reenlistment rates than individuals in pay grades E1-E3. Those in pay grades E1-E3 had low reenlistment rates at the SRB 1 level compared to soldiers in grade E4 and above, and little improvement was noted as the bonus level increased.

(5) At the SRB 1 level, the difference in the responses of soldiers with dependents and those without dependents was not significant. As the bonus level was increased, individuals with dependents exhibited higher reenlistment propensities than those without dependents.

(6) The general trends in reenlistment which emerge when viewing the four retention factors (race, education, pay grade, number of dependents) both in concert and in isolation reinforce the need to view the attributes of the soldier in more than one dimension. The multidimensional view permits improved estimates of the kind of soldier the Army will attract with an incentive policy and where, if possible, to focus that policy.

b. Force projections at the MOS/grade/year of service level of detail can be improved using MOS-unique continuation rates developed for the CEABREP system.

c. There are cost effective alternatives to high SRB levels. These alternatives can provide flexibility to managers and appeal to a wider spectrum of potential reenlistees. Such alternatives should be used to alleviate imbalances in MOS and should not be used as general reenlistment inducements.

d. Implementation of the CEABREP system would provide the potential for improved management of the incentives program through the use of automation. The system would provide the capability of analyzing reenlistment in terms of policies, monetary incentives, and exogenous influences which cumulatively constitute the reenlistment environment.

(1) The data base to support the CEABREP system design does not currently exist. Implementation of the CEABREP system would require that MILPERCEN collect demographic data on accession cohorts, institute data quality assurance procedures, and maintain data spanning at least five years.

(2) The data base acquired to support the CEABREP system would provide a source of data to support other Category 1 Manpower/Personnel studies dealing with the demographic characteristics of Army enlisted personnel.

APPENDIX A
STUDY CONTRIBUTORS

1. STUDY TEAM

   a. Study Director

      MAJ Calvin M. Anderson, Methodology, Resources and Computation Directorate

   b. Team Members

      MAJ Anthony K. Holtry

      Mr. Rene' R. Plourde

   c. Support Personnel

      Ms. Darrie-Ann Anderson

      Ms. Thelma Laufer

      Ms. Geraldine Sabo

      Ms. Susan Wolpert

      Ms. Elizebeth Demshock, WPC

      Ms. Julie Fuller, WPC

      Ms. Linda Prieto, WPC

      SSG Norman E. Price, Graphics

      SSG Moeolo F. Taamai, Graphics

PRODUCT REVIEW BOARD

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MAJ Mitchell E. Bonnett, Jr., Methodology, Resources and Computation Directorate

OTHER CONTRIBUTORS

LTC Henry Lee, War Gaming Directorate

Mr. Jerry Thomas, Methodology, Resources and Computation Directorate

Mr. Michael Lee, MILPERCEN

Ms. Louise Healey, MILPERCEN

APPENDIX B

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APPENDIX C

DEVELOPMENT OF THE CEABREP SYSTEM

C-1. OVERVIEW OF THE CEABREP SYSTEM. This appendix develops the complete automated CEABREP system which could not be implemented because of data limitations. The complete macro-level ADP system design shown in Figure C-1 uses the existing Personnel Inventory Analysis/Year of Service Model (PIA/YOS) as a major component. As a first step in applying the methodology, force projection accuracy is improved by using MOS-unique continuation rates. (See Chapter 3.) Costs of the SRB at all levels and policies currently in effect are obtained and applied on a per man basis. The components of cost and the force projection provide the capability of assessing the current force in terms of MOS fill and cost. If the manager considers the degree of fill to be inadequate or the cost too high, the capability is provided to evaluate the historical effects of bonuses and policies to formulate new alternatives. If the alternative involves implementation of a policy or an increase in a bonus level, such data must be quantified in terms of continuation rates by MOS, grade, and year of service for input to the model; the model then projects the force as it would appear under revised inducement policies. Total cost can then be developed for these new policies and the process continued until a policy set is developed which satisfies cost and force constraints. Within this appendix, a narrative description of the various operations is given to explain the system logic. Each narrative description is supported by a series of "Hierarchical Input-Process-Output (HIPO)" flow diagrams with extended narrative to support programing.

C-2. DATA REQUIREMENTS. The CEABREP methodology requires the use of two primary data sets. The first of these data sets consists of series of accession cohort files which provide demographic data on each soldier who entered the service during a five-year period. The accession cohort files provide the basis for developing continuation rates from the initial enlistment period into the career force. These rates are functions of Army policies, demographic data, and exogenous influences such as unemployment. The second data set consists of historical strength data used to estimate continuation after the first reenlistment. This historical data, taken from the ODCSPER 411 Report, provides the information required for the derivation of MOS-unique continuation rates discussed in Chapter 3. The remainder of this appendix will show how the data sets are used in conjunction with other models within the CEABREP system to provide the manager insights into the reenlistment environment.

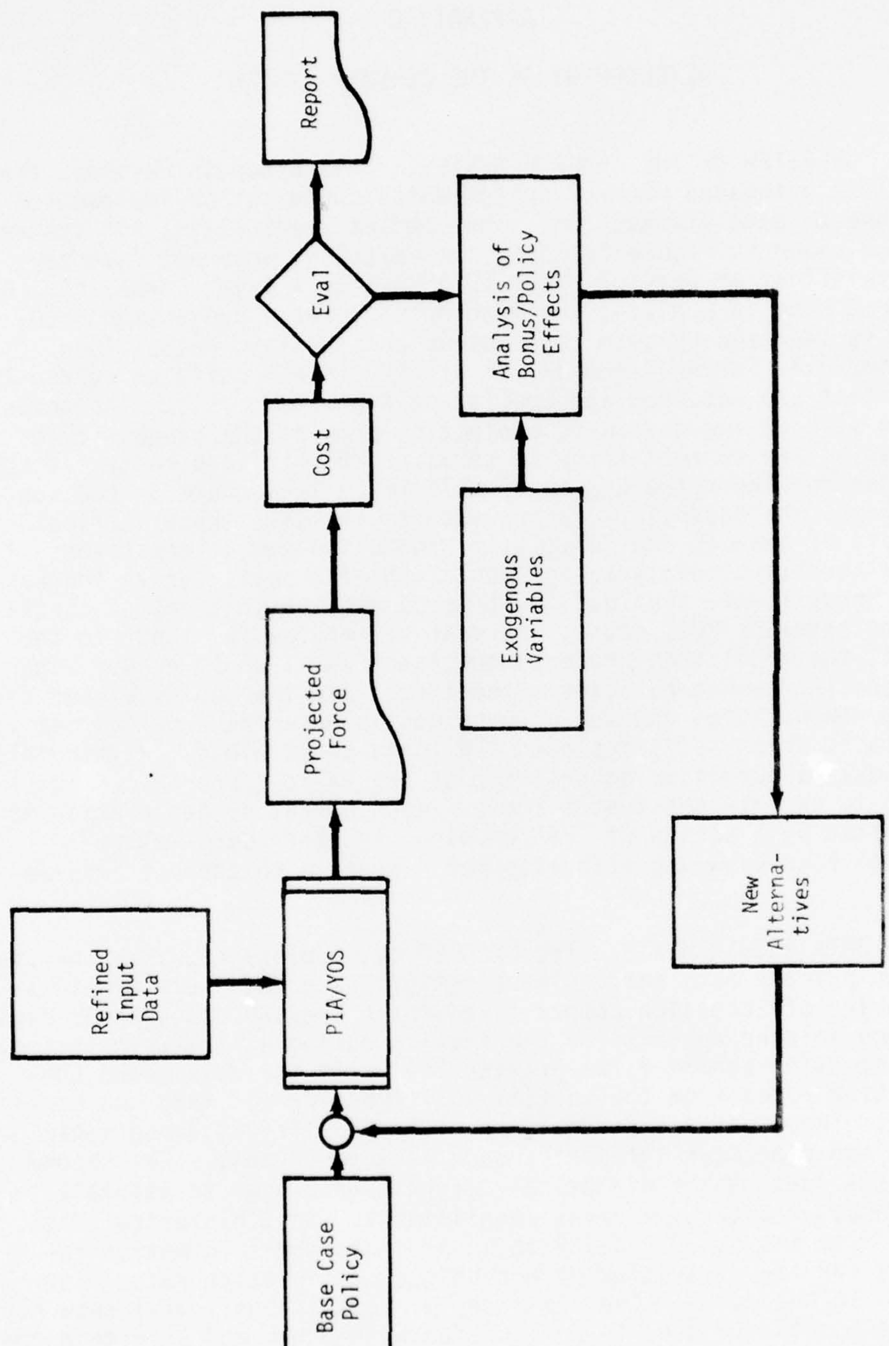

Figure C-1. The CEABREP System

C-3. THE STRUCTURE OF THE COHORT FILES. The primary data elements used by MILPERCEN are frequently coded to reduce record sizes (e.g., code E denotes high school diploma graduate). While this coding may be useful from a data processing standpoint, the technique introduces inefficiencies in historical files because of frequent changes in codes. To avoid the problem of updating the cohort files as regulations change and to facilitate subsequent use of the files, all entries are required to be numeric with an external master list to map the codes to their meanings. Actual cohort files are not maintained within the CEABREP data base; a precohort data base is maintained in third normal form* and required cohort files are constructed as needed. Structuring the cohort files when they are needed allows annual files to be produced without being restricted to artificial limitations such as fiscal years. The record format within the precohort data base is shown in Table C-1. As an example of the flexibility of the data base, the FY 74 accession cohort could be constructed by selecting those social security number records from the basic record set with first transaction dates occurring between 1 July 73 and 30 June 74. Given the SSAN keys from the basic records, transaction record data can be added to complete the file. For data processing efficiency the cohort files are ordered by MOS. The data base structure permits cohort files to be constructed by calendar year or any other cutoff date; however, because the remainder of this report deals with fiscal year cohort files, the examples of this chapter will also use fiscal year cohort files and assume the existence of the FY 72 to FY 76 files.

C-4. DETERMINATION OF SUBPOPULATION CHARACTERISTICS. A premise of the CEABREP methodology is that reenlistment behavior can be estimated as a function of certain demographic characteristics of the eligible population. The precohort data base structure of Table C-1 lists 31 candidate variables which could be used to define more homogenous subgroupings of the population according to reenlistment behavior. While all 31 variables may provide insight on reenlistment, there are too many possible combinations to permit exhaustive sets of estimating relationships to be formed. As described in Chapter 4, the techniques used to estimate reenlistment as a function of the SRB level require that the force be defined in four or at most five dimensions.

*A file of records is said to be in third normal form if the key for each record is unique and if all non-key elements of a record are dependent on the key and independent of each other.

Table C-1. The Pre-Cohort Data Base Structure

Base Record[a]	Transaction Record[b]
1. Social Security Account Number - key	1. Social Security Account Number - key
2. First Transaction Date	2. Transaction Date - key
3. Age at Enlistment	3. Transaction Code
4. Enlistment Term of Service	4. Education
5. Enlisted/Drafted Status	5. Primary MOS
6. Lottery Number	6. MOS Score
7. Race	7. Duty MOS
8. Mental Category	8. Pay Grade
9. Sex	9. SRB Level Paid or Eligible at Separation
10. Enlistment Option	10. Marital Status
11. Training Committment	11. Number of Dependents
12. State (Home of Record)	12. Assignment Code
13. Recruiting Main Station	13. Location Code
14. AQB/ACB Test Scores	14. Reenlistment Option

[a]One Basic Record per Social Security Number.

[b]Multiple Records per Social Security Number.

a. The Automatic Interaction Detector III (AID III) Model is used to reduce the 31 candidate predictor variables by selecting the four or five variables that provide the most discrimination. The use of the AID III Model is shown in Figure C-2. In this example (and the rest of the examples in this appendix) the FY 72-FY 76 accession cohorts will be used to predict the FY 77 population. Of those entering service in FY 73, three-year enlistees must have reenlisted, extended or separated during or prior to the end of FY 76. Three-year enlistees of the 74 cohort would not be required to make a decision until FY 77 even though some may have reenlisted or extended prior to their Expiration of Term of Service (ETS) date. Thus, the FY 73 cohort provides the most recent available information on the reenlistment behavior of three-year enlistees and that data is used to determine the set of variables exerting the most influence on reenlistment of three-year enlistees.

b. Two actions are necessary in preprocessing the FY 73 file before the AID Model is used. First, the records of four-year enlistees must be removed from the data set because their reenlistment decision is not forced until FY 77, and secondly, the three-year enlistee records must be stratified according to the SRB which was paid at reenlistment or for which they were eligible at the time of separation. The SRB stratification is necessary because the SRB is used selectively (i.e., at MOS level); if not stratified, the SRB itself could become a factor determining the subpopulation definition rather than a factor which influences a subpopulation. Each of the stratified sets is then input to the AID Model according to a problem definition deck which revises the data as necessary to conform to AID requirements. The AID Model will accept a maximum of 31 classes per variable which may require that certain variables such as MOS be grouped. This grouping can be accomplished internally as part of the problem definition deck as explained in the AID III System Documentation (see Chapter 2). (The AID Model is inefficient from an I/O standpoint and an external utility routine to accomplish the groupings may be useful.) It is unlikely that the AID Model will produce identical subpopulations at each level of the SRB. This difference may be caused by correlation between variables and random variation of the data. It is possible that the AID results could differ significantly between SRB levels; however, based on analysis of the FY 71 accession cohort, this degree of variability is unlikely. More probable is that the same general set of variables will appear at all SRB levels although perhaps not in the same order. This was the case with the FY 71 accession cohort as shown in Appendix E. From the AID results at all SRB levels a general set of predictor variables is selected that defines subpopulations with homogenous reenlistment behavior. The next step is to develop MOS continuation rates for these subpopulations.

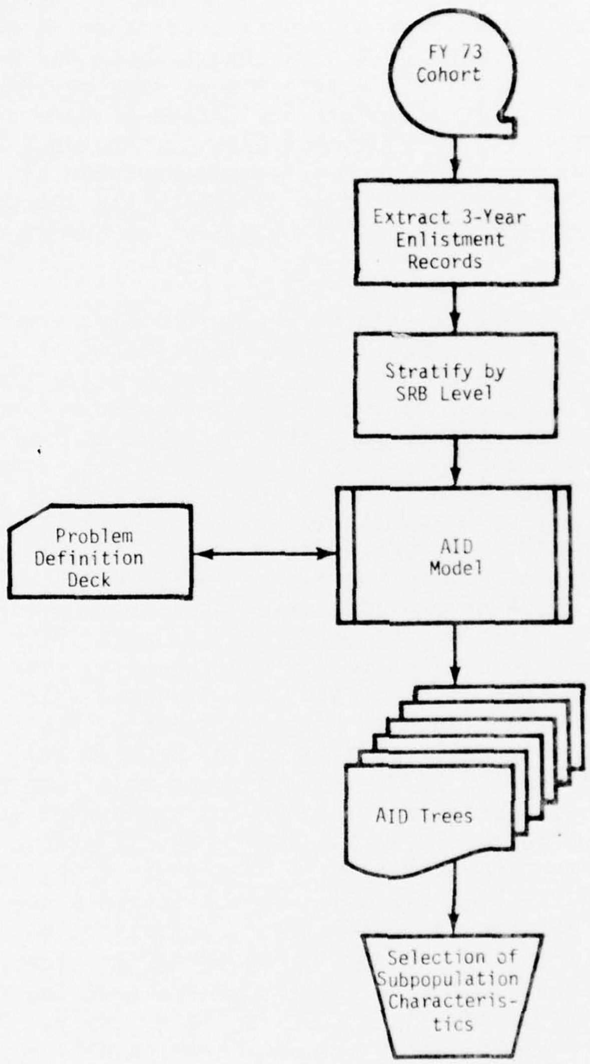

Figure C-2. Example of an AID III Model
Set-up and Execution

C-5. DEVELOPING FIRST AND SECOND YEAR OF SERVICE CONTINUATION RATES. The FY 75 and FY 76 cohorts are used to determine first year of service continuation rates. This process is shown in Figure C-3.

a. Every FY 75 accession must either have left the Army or entered the second year of service by the end of FY 76. The transition of the FY 75 cohort from the first to the second year of service permits derivation of first year of service continuation rates by subpopulation. The FY 76 accession cohort is structured to be sorted by subpopulations within MOS and is then used in conjunction with the first year of service continuation rate by subpopulation to derive continuation rates which are applicable at the MOS level of detail. Transformation of the subpopulation continuation rates to MOS continuation rates is accomplished in three steps: first, the MOS is sorted by the subpopulations that comprise the MOS; second, the percentage of each subpopulation to the total MOS population is computed; third, a convex combination of the subpopulation continuation rate is formed using the proportional distribution of the subpopulations within the MOS. (See Table 3-3 for an example of convex combination.) The convex combination provides the single continuation rate for each MOS which has been weighted according to the current population of the MOS in the first year of service.

b. The same techniques are used but applied to different data sets to develop second year of service MOS continuation rates. The FY 74 cohort is stripped of first year of service losses to determine how subpopulattions which were in their second year of service continued to the third year of service. The FY 75 cohort is updated to the current second year of service force by stripping off first year of service losses from the file. The subpopulation continuation rates derived from the FY 74 file are then applied to the current force to derive MOS continuation rates for the second year of service weighted according to the characteristics of the people in each MOS.

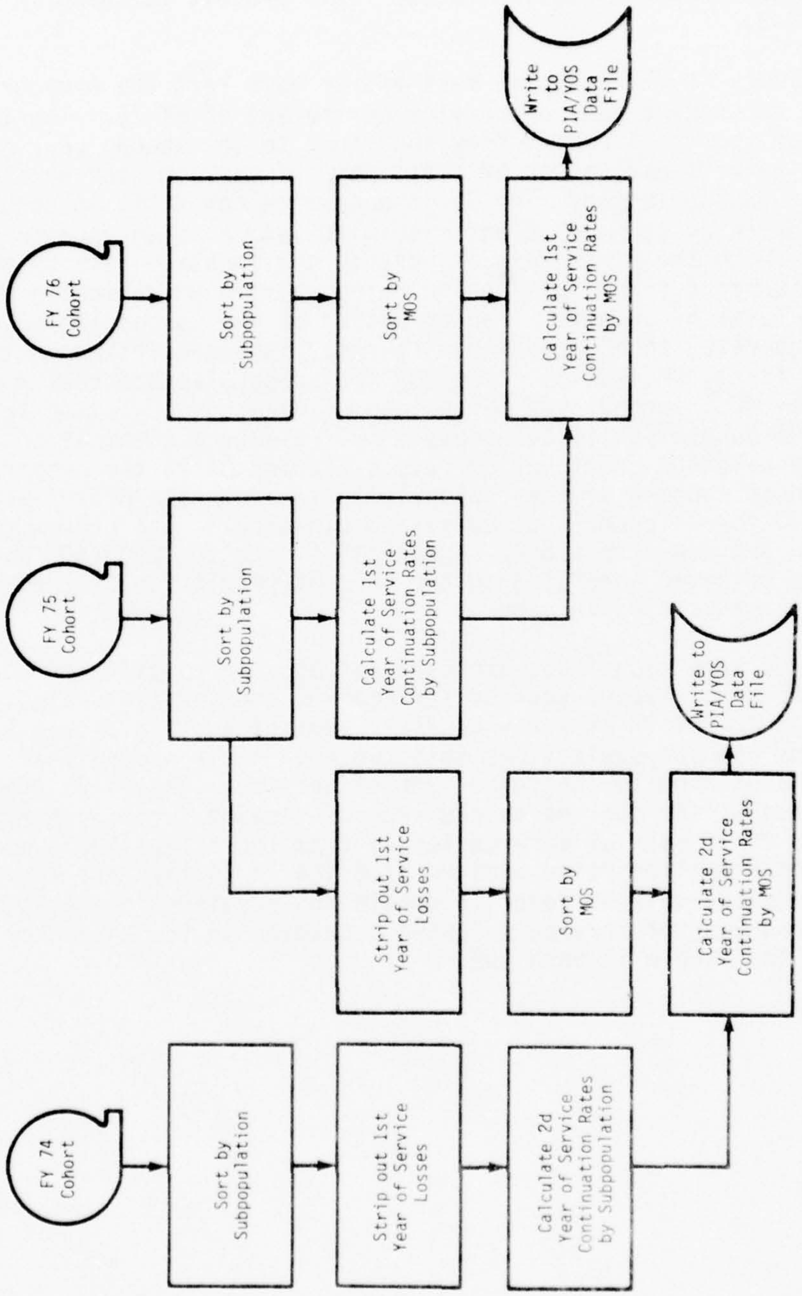

Figure C-3. Computing First and Second Year of Service Continuation Rates

C-6. DERIVATION OF THIRD YEAR OF SERVICE CONTINUATION RATES. Derivation of continuation rates for the third year of service is complicated by the reenlistment process for three-year accessions compounded by normal continuation of the four-year accessions who are continuing under their normal enlistment terms of service. This combination of effects requires data from the FY 73 cohort to be divided by enlistment obligation.

a. Figure C-4 illustrates the computation of continuation rates for the third year of service using the FY 73 and FY 74 accession cohorts. This figure is in two parts, A and B. Part A illustrates the method used to compute reenlistment estimates for three-year accessions. The three-year enlistment records are first extracted from the cohort file. These records are then sorted by subpopulation and stratified by SRB. Count data on the number of reenlistments and separations are accumulated for each SRB level for each subpopulation. If the subpopulation has 100 or more total reenlistments and separations for at least three SRB levels, weighted linear regression is used to provide an estimate of continuation as a function of the SRB (see Chapter 4, paragraph 4-3). If the above criterion is not satisfied, a joint probability distribution function is constructed from the marginal distributions (see Chapter 4, paragraph 4-3). A separate or marginal distribution is computed for each class of the variables defining subpopulations. For example, if one variable that defines the subpopulations is race, count data is summed over all other variables to provide estimates of reenlistment as a function of the SRB and race. If a second variable that defines subpopulations is education, the count data is summed over all other variables (including race) to provide an estimate of reenlistment as a function of the SRB and education. When all of the marginal distributions have been constructed, one joint probability distribution function is computed using constants of proportionality. This technique was used in analysis of the FY 71 cohort and an example of the use of the technique is explained in Chapter 4.

b. Having described reenlistment behavior as a function of the subpopulations and the SRB, the next requirement is to adjust these estimates on the basis of projected values of exogenous variables and policy decisions. This adjustment involves a two step process. The first step is to determine the effect of the exogenous variables in isolation. The second step is to adjust the SRB estimates to compensate for expected changes in the values of the exogenous influences. Time-lagged linear regression is employed on subpopulation data to estimate the effects of the exogenous and policy variables on real time reenlistments for the most

recent 12-month period.* Because of early reenlistments, both the FY 73 and FY 74 cohorts must be used to insure that all reenlistments taking place in a month are included. When the lag time has been determined, average values of the exogenous variables which affected the FY 73 Cohort can be computed. The FY 73 cohort was used to develop the SRB estimates and the average values in effect when those estimates were made provide a baseline for adjustments. These average values are computed based on when the separation and reenlistment transactions of the FY 73 cohort took place. For example, if 10 transactions took place when the unemployment rate was 8 percent and 20 transactions took place when unemployment was 9 percent, the average value for unemployment would be:

$$\frac{(.08)(10) + (.09)(20)}{30} = .087$$

On completing time-lagged regression, the FY 74 three-year records are stripped of loss records and sorted by MOS. With user-specified estimates for the values of exogenous variables, sets of reenlistment rates are computed; these rates are computed by adjusting the SRB-subpopulation estimates according to the changes in the values of the exogenous variables from the average value in effect when the SRB subpopulation estimates were made. The time-lagged linear regression indicates the amount and the direction of adjustment (e.g., an expected one percent increase in unemployment may portend a two percent increase in reenlistment rates for a certain subpopulation). A set of rates is required to provide the capability of evaluating alternative policies that are within the manager's span of control. For example, one group of SRB rates could apply to a subpopulation in the absence of the CONUS-to-CONUS station of choice reenlistment option, and another group of rates might apply when the option was made available.

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*To test the appropriateness of using time-lagged regression, the technique was used on aggregated reenlistment data collected by ODCSPER and unemployment rates for males aged 20 to 24. In this test, reenlistment data lagged the unemployment rate two months in time; the results of the test rejected independence of the two variables at the 0.001 level of significance.

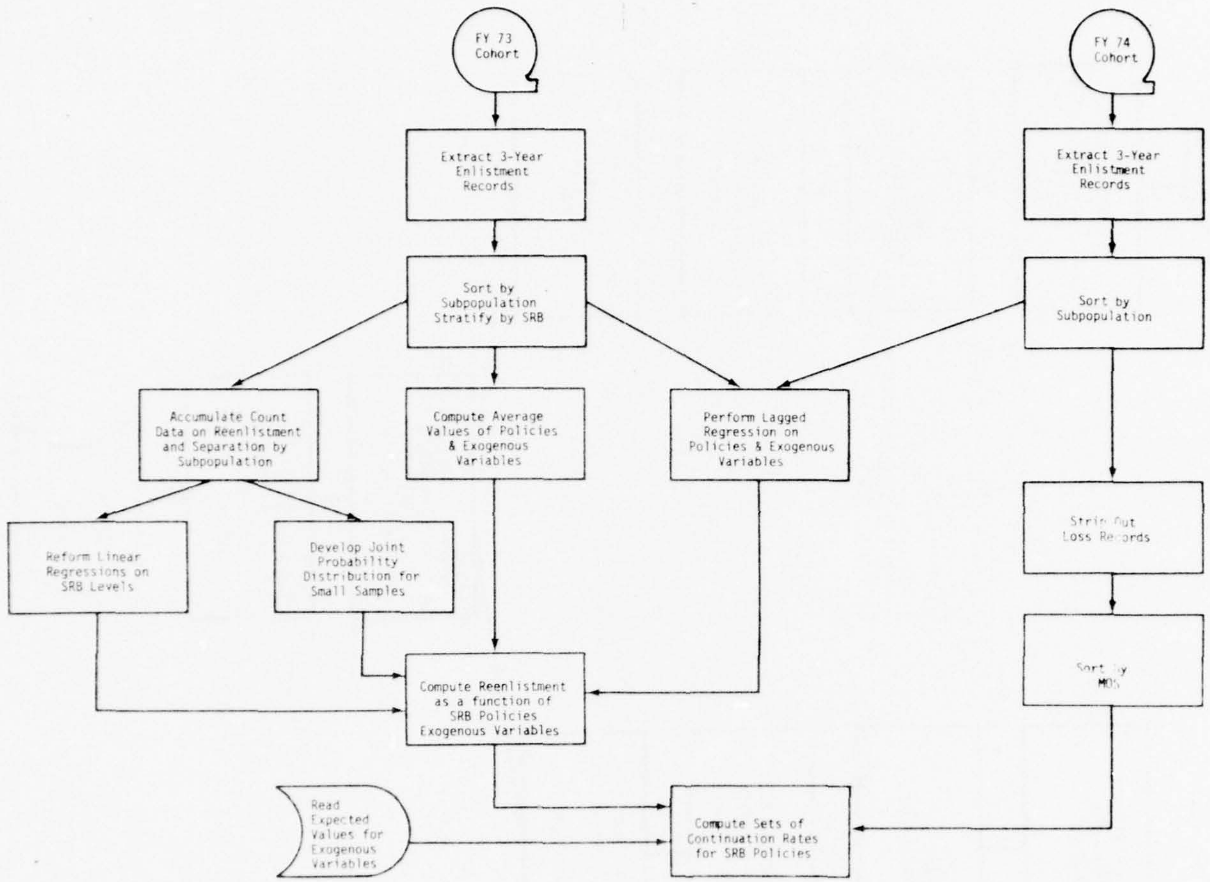

Figure C-4 (Part A). Computing Third Year of Service Continuation Rate

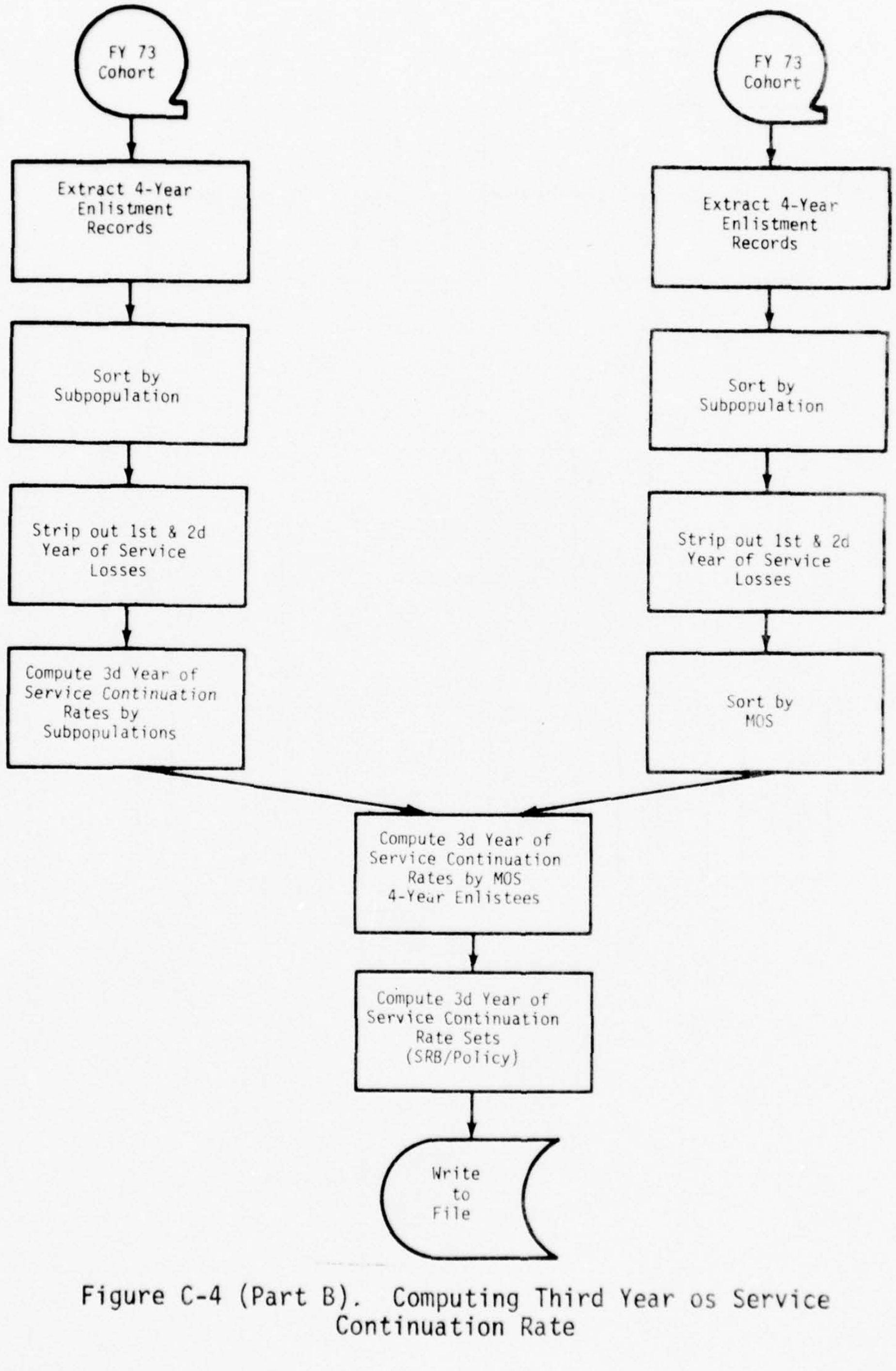

Figure C-4 (Part B). Computing Third Year os Service Continuation Rate

c. The next step in computing third year of service continuation rates is to calculate continuation rates for four-year enlistees who are not in the reenlistment eligible zone. As shown in part B of Figure C-4, this process is equivalent to the method used in calculating continuation rates for the first and second years of service. The final step in the process is to combine the three-year enlistment/reenlistment rate and the four-year enlistment continuation rate into a single rate applicable to the third year of service. This is done at the MOS level by forming convex combinations of the continuation rates according to the mix of enlistment obligations, that is, three- and four-year enlistees within the MOS.

C-7. DERIVATION OF FOURTH YEAR OF SERVICE CONTINUATION RATES. Derivation of continuation rates applicable to the fourth year of service involves the same methods used for the third year of service. For the fourth year of service it is the four-year enlistee who must reenlist while the three-year enlistee (who has already reenlisted) simply continues in service. The algorithms used to calculate reenlistment rates for three-year enlistees can be used for four-year enlistees by extracting four-year enlistee records from the FY 72 file and stripping out losses which took place during the first three years of service. Similarly, an extract of three-year enlistee records can be used in the algorithms which calculate continuation rates for four-year enlistees in their third year of service. For those MOS which have been offered an enlistment bonus, the result will be a set of continuation rates reflecting alternative bonus and policy levels.

C-8. CONTINUATION RATES FOR THE CAREER FORCE. Cohort file techniques could be used to develop estimates of continuation for the career force. This technique is not currently used nor is it recommended because of the size and number of data files which would be required and because of the relatively high and stable reenlistment rates which have been exhibited by the career force. An alternative method of computing MOS-unique continuation rates uses historical data on MOS populations by grade and year of service in conjunction with the PIA/YOS feeder patterns to develop continuation rates for the career force. A heuristic explanation of the derivation method is given in Chapter 4. A more rigorous

derivation is contained in CAA Technical Paper, CAA-TP-77-3.* To illustrate results, the continuation rates for the maneuver combat arms are shown in Appendix D.

C-9. THE BASE CASE AND FORMULATION OF ALTERNATIVES. MOS-unique continuation rates provide a set of rates for projecting the career force and cohort data files provide the basis for computing rates for the first four years of service. Sets of rates have been derived for the third and fourth years of service for each MOS. These sets include expected reenlistment rates for the three- and four-year enlistees for all SRB levels under various policy alternatives. Because the PIA Model requires a single rate for each MOS, the system user must specify an SRB level and a policy environment for each MOS. The simulation will then provide a projected force reflecting the policies in effect and the SRBs offered for either the base case, that is, current policies and bonus levels, or for excursions to SRBs and/or policies specified by the manager.

C-10. APPLICATION OF COST DATA. Cost data on a per man basis is readily available for most policies. As examples, the Monetary Incentives Branch of MILPERCEN maintains data on the average SRB paid and the Office of Plans, Programs and Budgets within ODCSPER maintains data on PCS costs. Training cost data is available from the Office of Cost Analysis, Office of the Comptroller of the Army. To apply these data requires information on the expected number of individuals who will accept the option if offered and the marginal improvement in reenlistment that can be expected. If an inducement is offered such as the CONUS-to-CONUS station of choice reenlistment option, some improvement in reenlistment could be expected; however, others who would have reenlisted without the option will probably accept the offer when made. If the option has been used within the time frame of the historical data, the reenlistment option code from the transaction record of the cohort file can be used to estimate the total expected number of reenlistees who would take the option if offered. Time-lagged linear regression techniques discussed in paragraph C-6 can then be used to estimate the expected marginal improvement in reenlistment as a function of the option. Applying these data to the number of reenlistment eligibles currently in the third and fourth years of service and multiplying by the cost factors provides an estimate of the total cost of offering the option.

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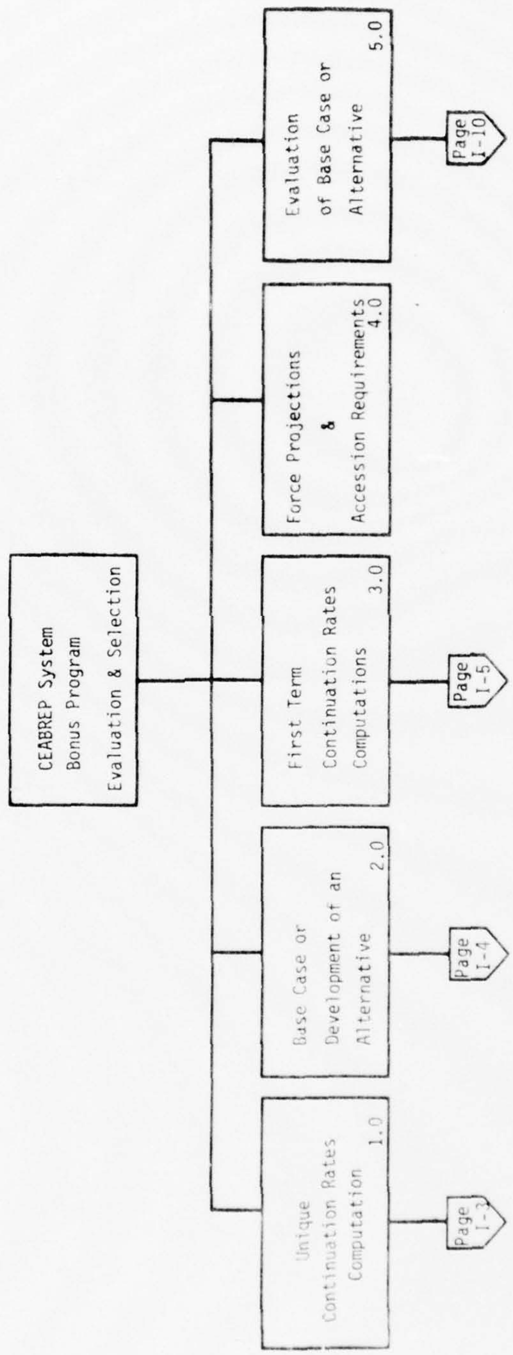
*US Army Concepts Analysis Agency, "Derivation of MOS-Unique Continuation Rates," Technical Paper CAA-TP-77-3, Bethesda, MD, Apr 77.

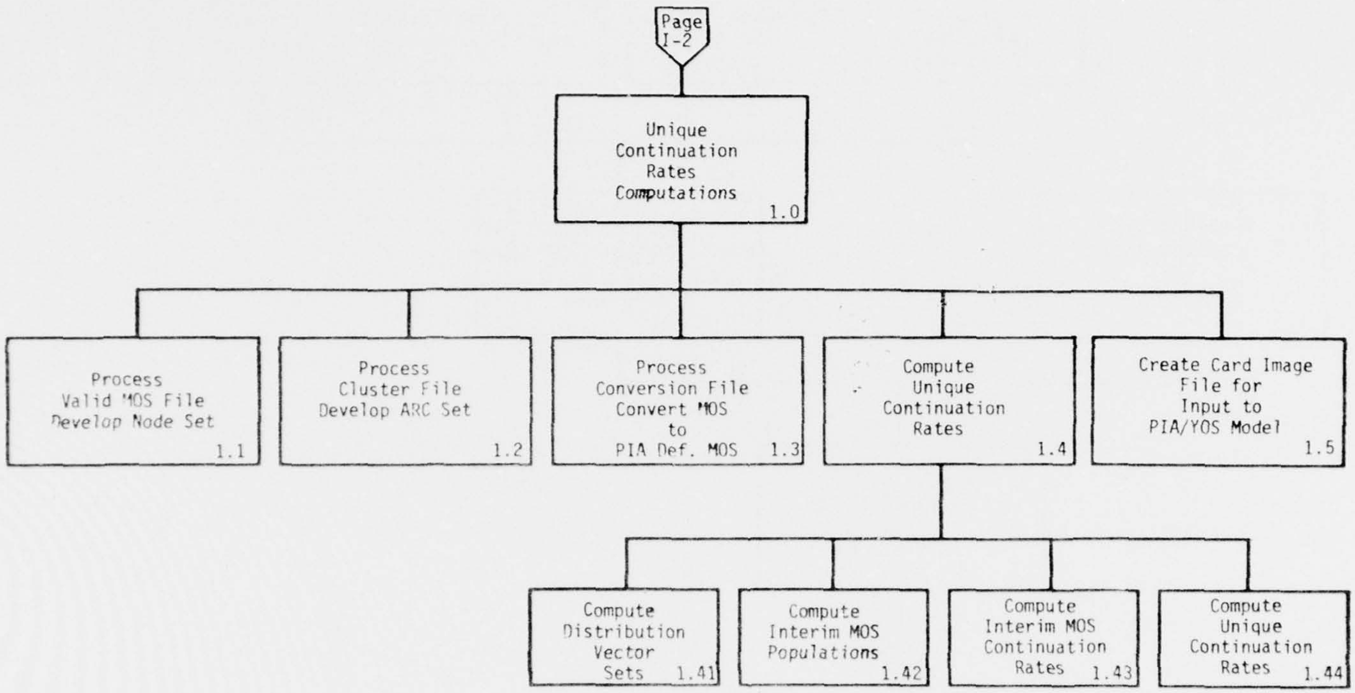
C-11. THE HIERARCHICAL INPUT PROCESS OUTPUT CHARTS. The previous paragraphs establish the desired structure of the data base (i.e., cohort files and strength data) and show how variations of current policies can be explored to provide insight into the cost and effectiveness of bonus decisions. The Functional Hierarchical Chart for the CEABREP system is at Annex I. The Hierarchical Input-Process-Output charts with extended narrative descriptions to support the functions are at Annex II.

APPENDIX C
Development of the CEABREP System

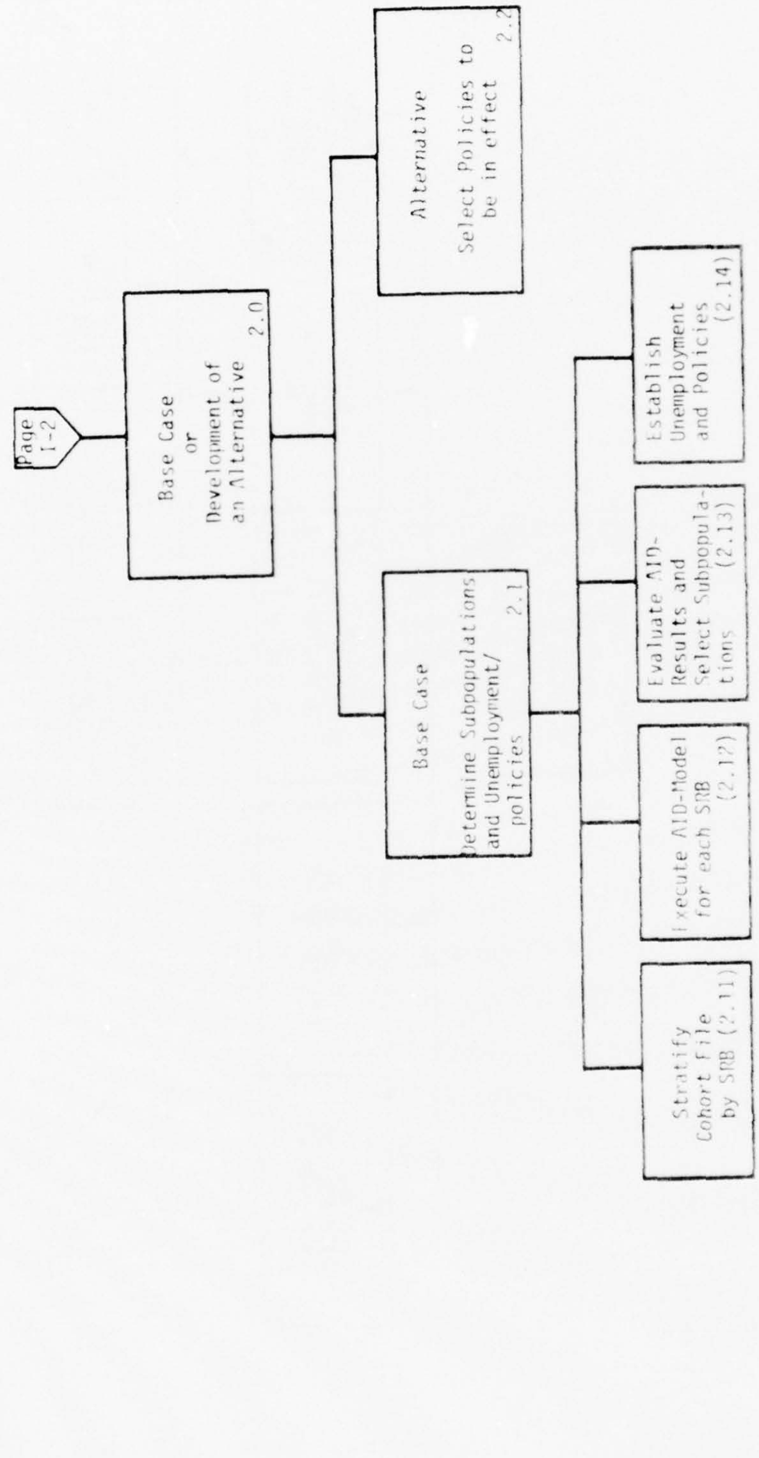
Annex I
Functional Hierarchical Charts



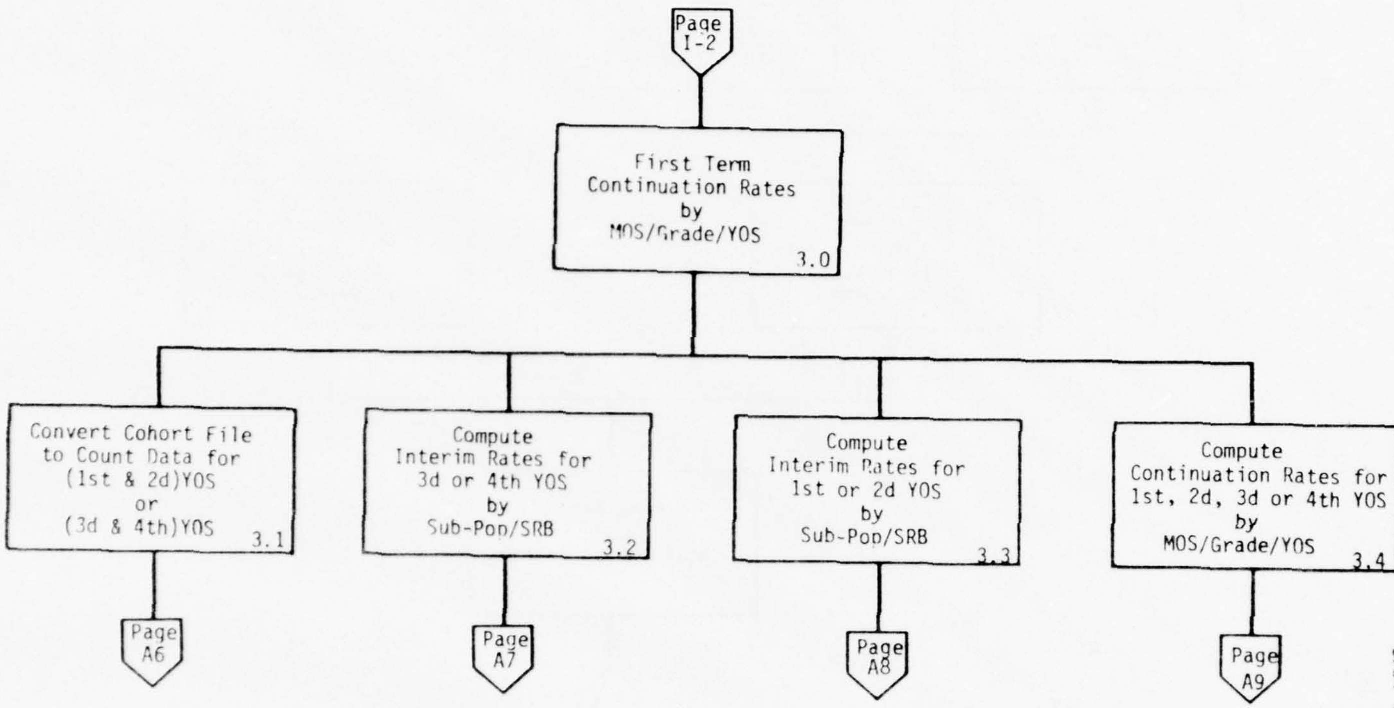
Functional Hierarchical Chart for CEABREP System



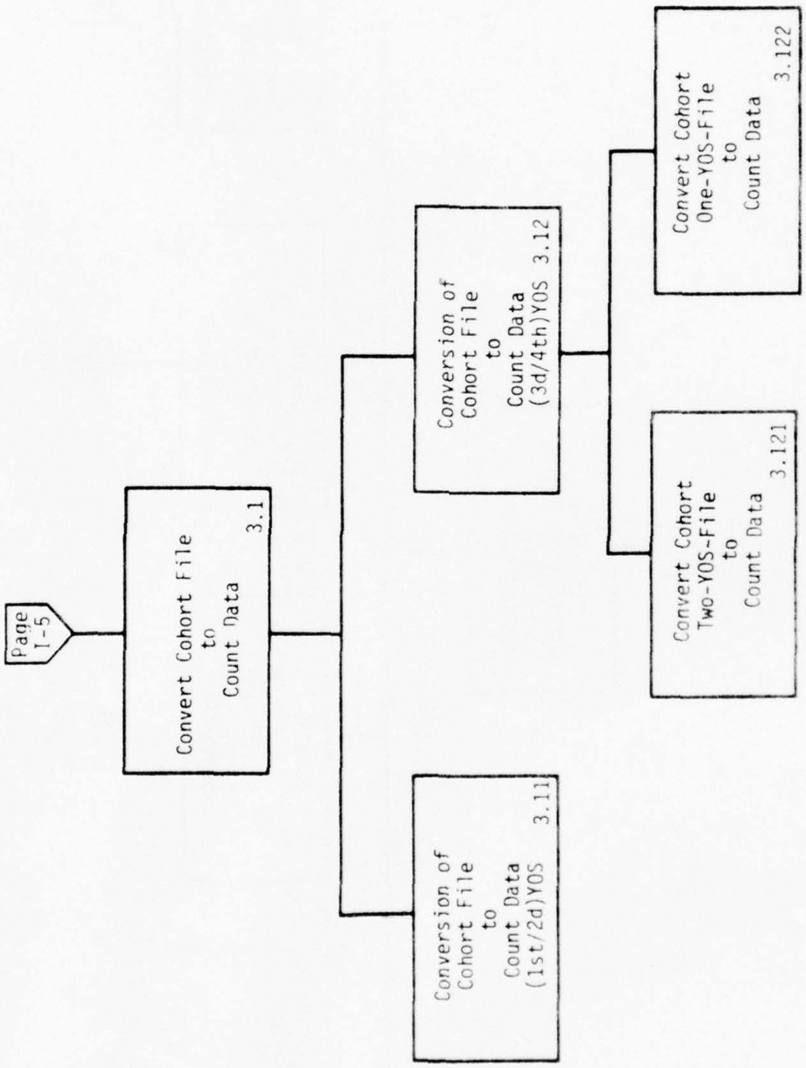
Functional Hierarchical Chart for Unique Continuation Rates



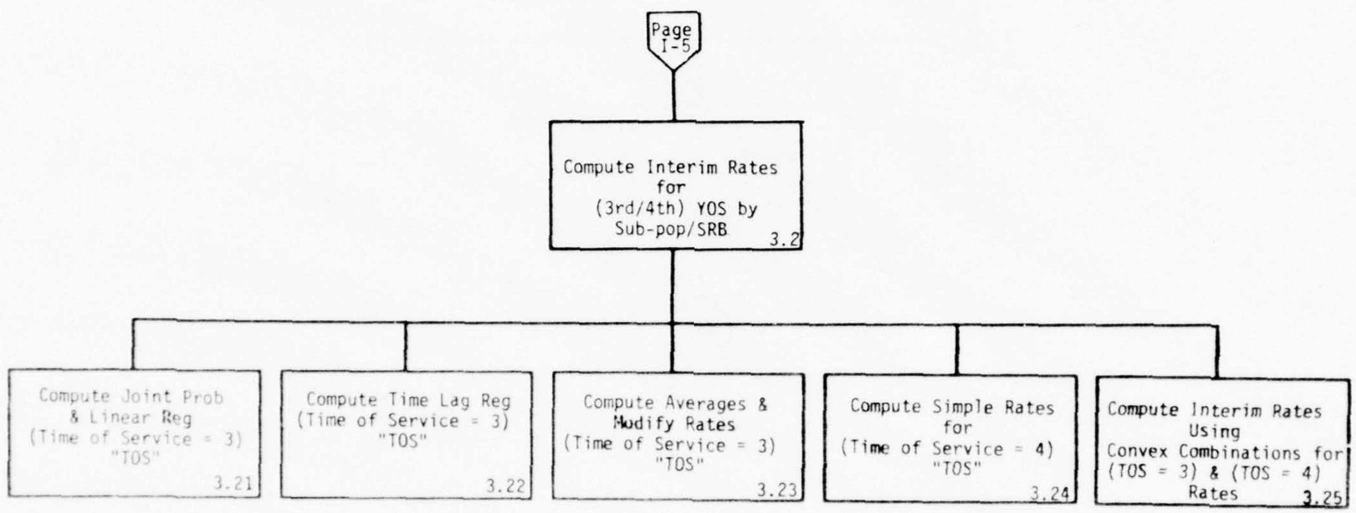
Functional Hierarchical Chart for Base Case/Alternative



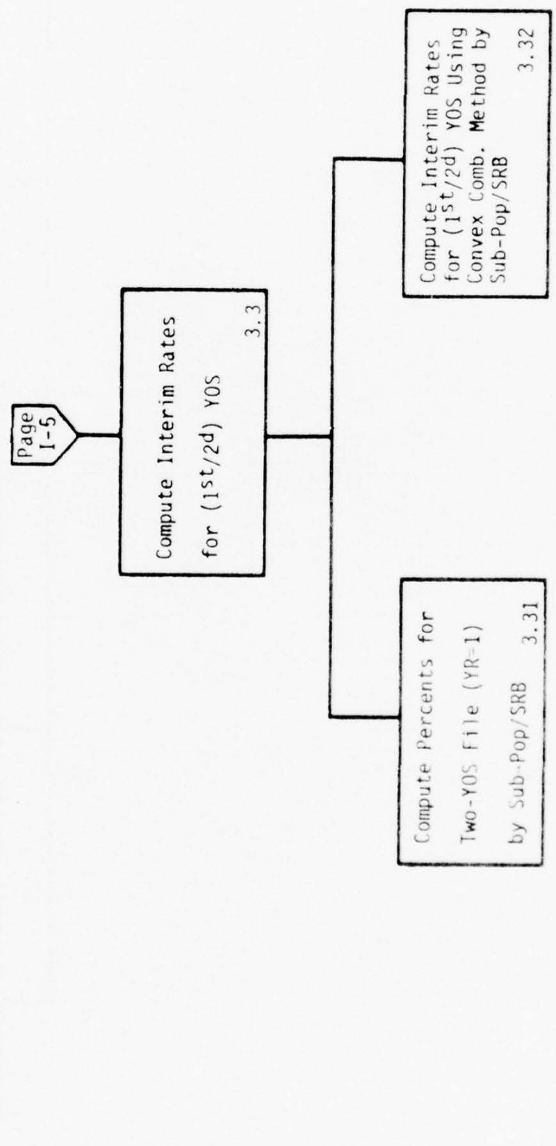
Functional Hierarchical Chart for First Term Continuation Rates



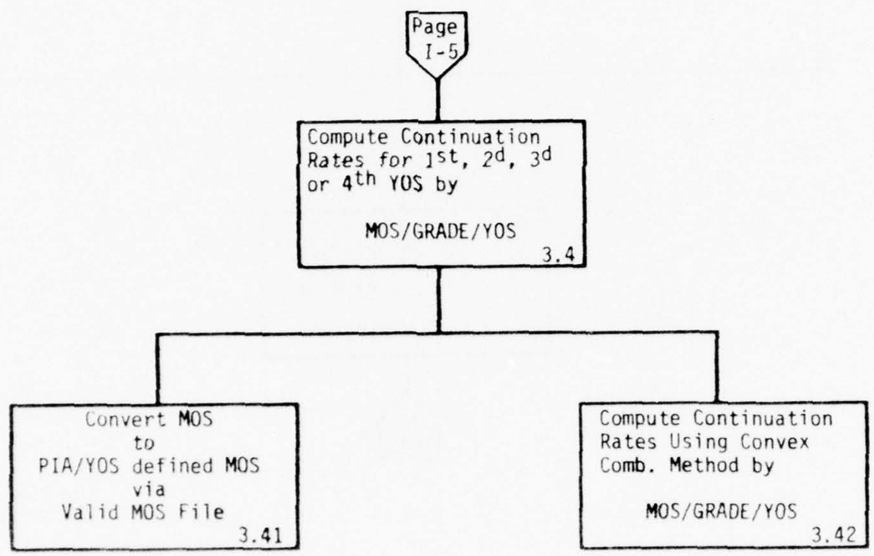
Functional Hierarchical Chart for Conversion of Cohort to Count Data



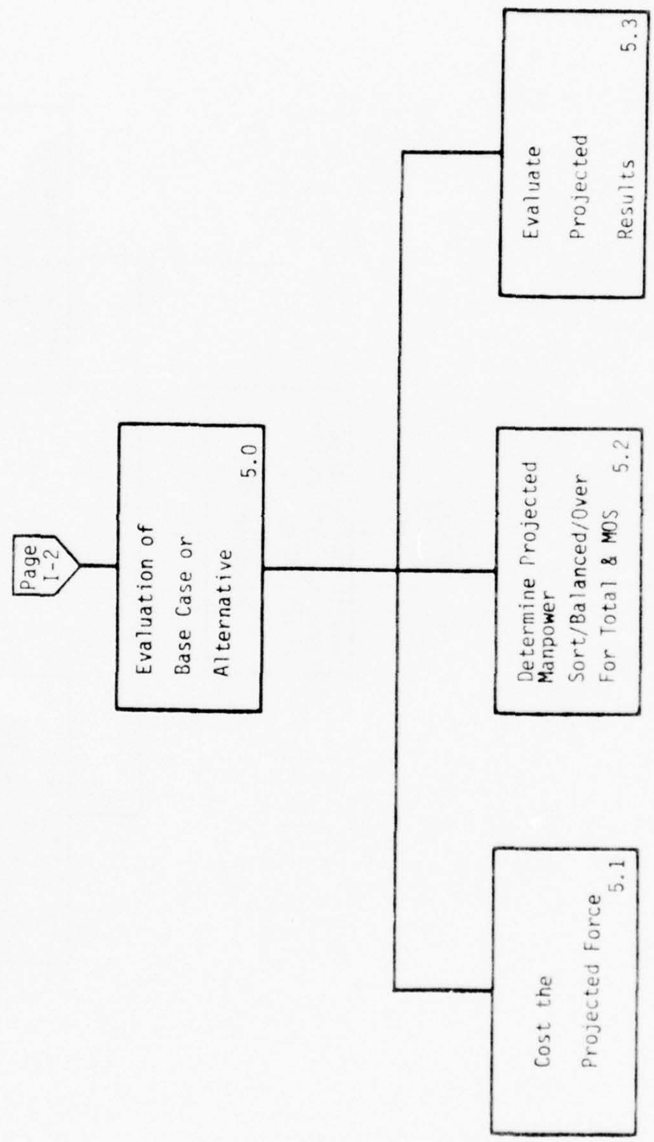
Functional Hierarchical Chart for Interim Rates 3rd/4th YOS



Functional Hierarchical Chart for Interim Rates 1st/2d YOS



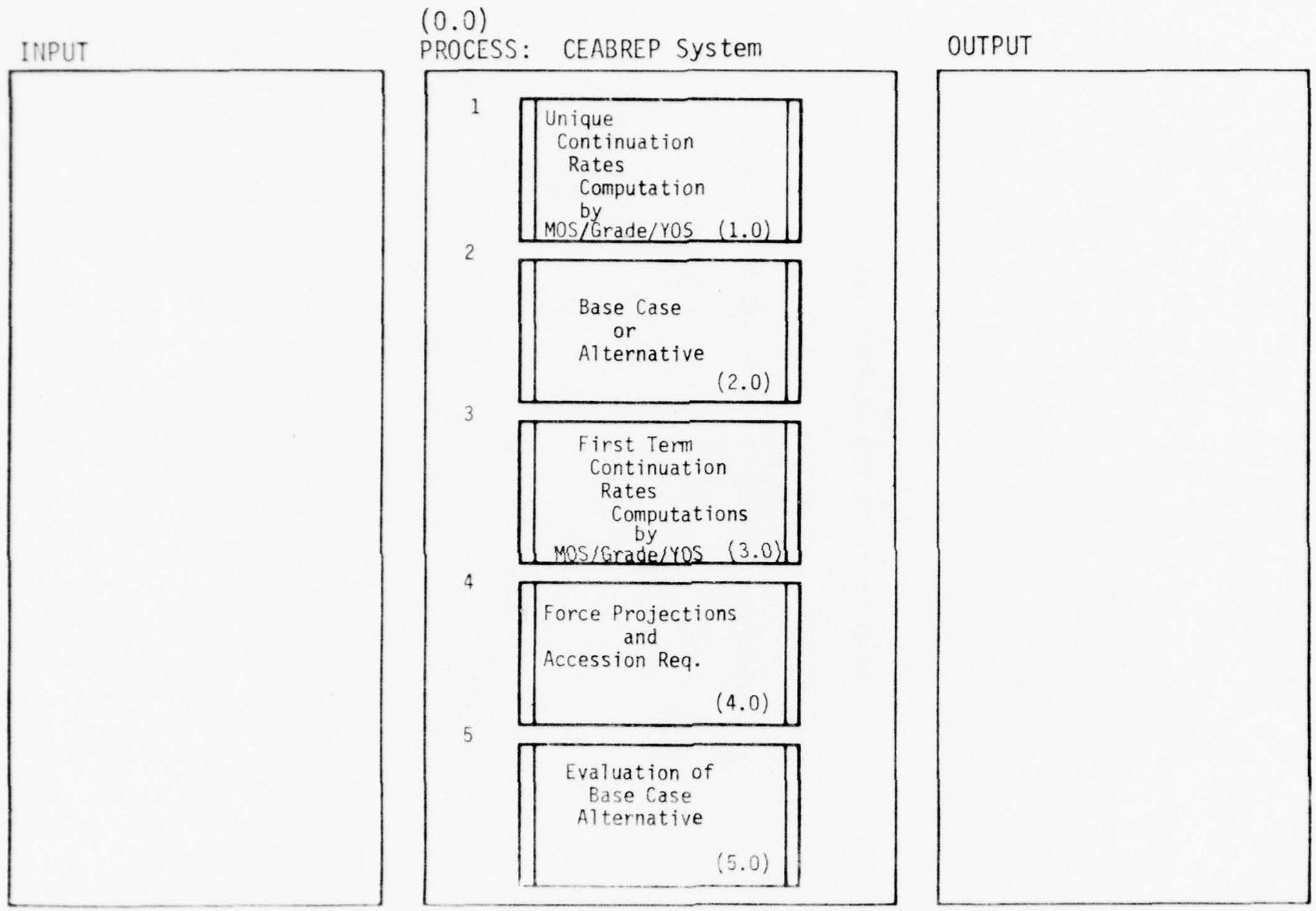
Functional Hierarchical Chart for Continuation Rates 1st/2d/3rd/4th YOS



Functional Hierarchical Chart for Evaluation of Base Case/Alternative

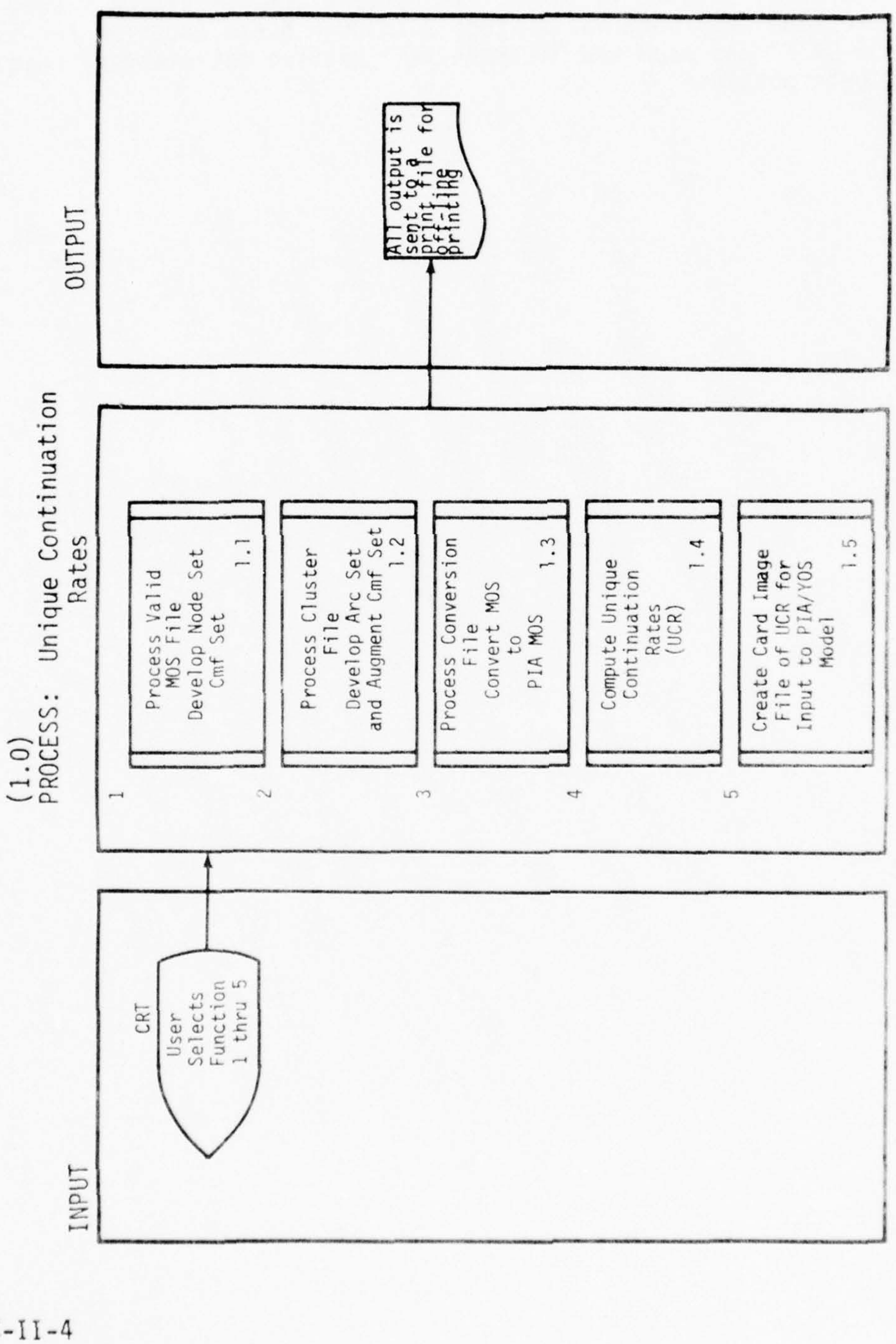
APPENDIX C
Development of the CEABREP System

Annex II
Hierarchical Input-Process-Output Charts


INPUT
(0.0)
PROCESS: CEABREP System
OUTPUT
1
Unique Continuation Rates Computation by MOS/Grade/YOS (1.0)
2
Base Case or Alternative (2.0)
3
First Term Continuation Rates Computations by MOS/Grade/YOS (3.0)
4
Force Projections and Accession Req. (4.0)
5
Evaluation of Base Case Alternative (5.0)

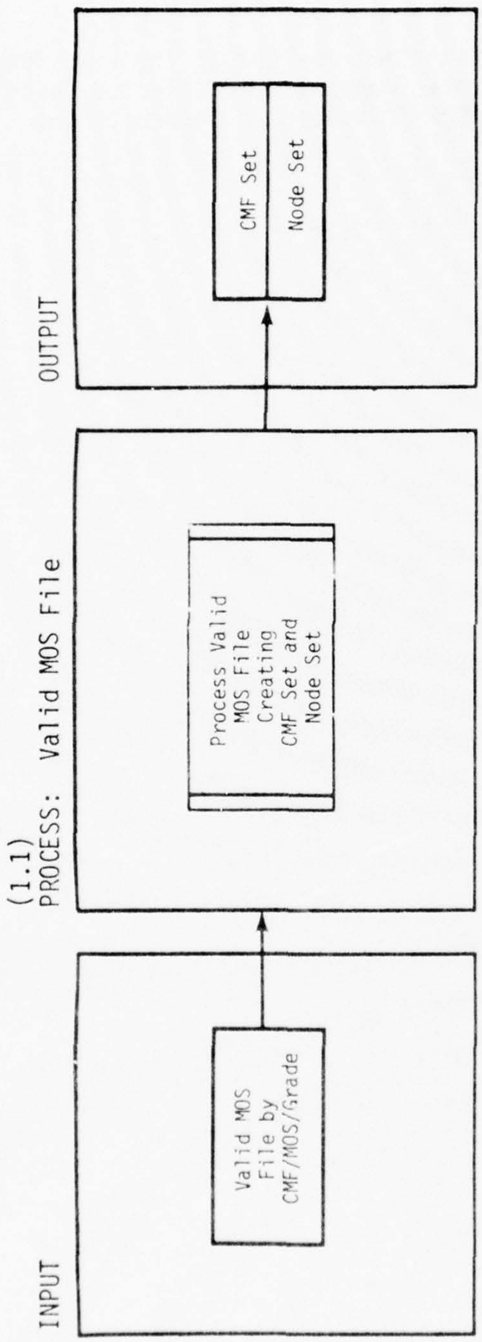
EXTENDED NARRATIVE FOR HIPO C-II-2

This process is used to control the entire CEABREP system. Step 1 is executed only once while steps 2 through 5 are executed for the "BASE CASE" and each new "ALTERNATIVE" until a satisfactory result has been obtained.


(1.0)
PROCESS: Unique Continuation Rates
INPUT
CRT
User Selects Function 1 thru 5
1
Process Valid MOS File Develop Node Set Cmf Set 1.1
2
Process Cluster File Develop Arc Set and Augment Cmf Set 1.2
3
Process Conversion File Convert MOS to PIA MOS 1.3
4
Compute Unique Continuation Rates (UCR) 1.4
5
Create Card Image File of UCR for Input to PIA/YOS Model 1.5
OUTPUT
All output is sent to a print file for off-line printing

EXTENDED NARRATIVE FOR HIPO C-II-4

This process allows the user to select any one of the five functions via CRT. After successfully completing a selected function the user can either select another function or return to the CEABREP system control process.

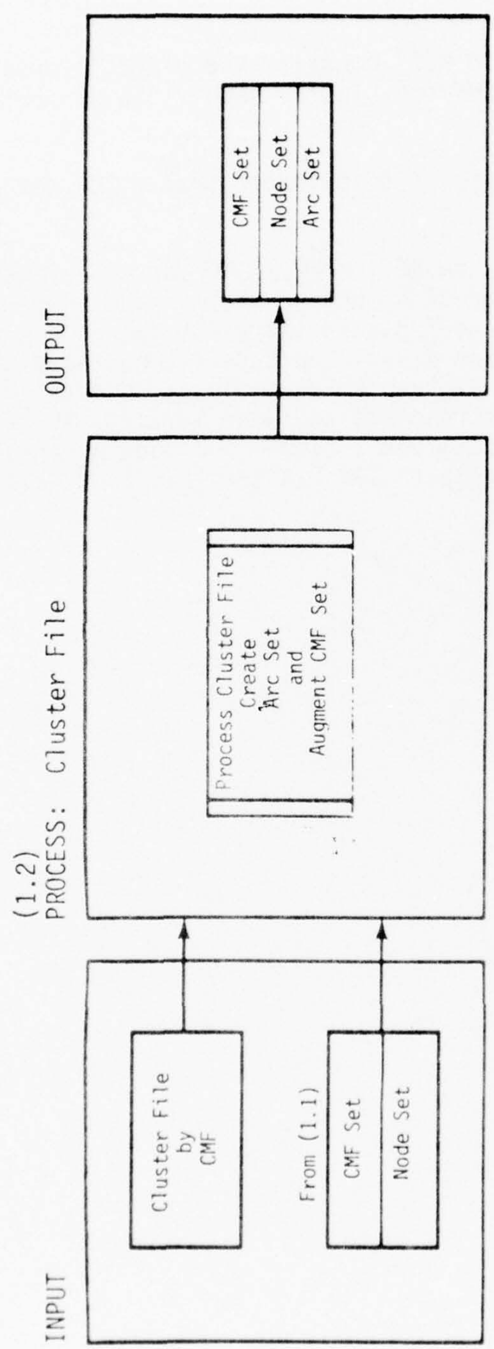

INPUT
Valid MOS File by CMF/MOS/Grade
(1.1) PROCESS: Valid MOS File
Process Valid MOS File Creating CMF Set and Node Set
OUTPUT
CMF Set
Node Set

EXTENDED NARRATIVE FOR HIPO C-II-6

INPUT: The input file "Valid MOS" contains the grade information for each valid MOS and the CMF/sub-cluster number the MOS belongs to.

PROCESS: The "Valid MOS" File is transformed into a CMF set and a node set.

OUTPUT: The CMF set is used to define each CMF and sub-cluster number and the maximum number of nodes and the maximum number of arcs. Where a node is used to indicate the existence of a population for a given MOS and grade pair. The Node set contains the information for each MOS of a given CMF/sub-cluster number in the form of: MOS, link to MOS strength data, Node Number 1 (E1-E3); Node Number 2 (E4);...; Node Number 7 (E9). The node numbers correlate to the node numbers used in the Cluster file (see C-II-8).


INPUT
Cluster File
by
CMF
From (1.1)
CMF Set
Node Set
(1.2)
PROCESS: Cluster File
Process Cluster File
Create
Arc Set
and
Augment CMF Set
OUTPUT
CMF Set
Node Set
Arc Set

EXTENDED NARRATIVE FOR HIPO C-II-8

INPUT: The Cluster file contains one record for each CMF. Each record contains pairs of node numbers along with a percent flow between the two node numbers. Each node number represents a unique MOS/Grade for a given CMF. These node numbers correspond to the node numbers used in the Valid MOS File, (see C-II-3).

PROCESS: Each record from the Cluster File is converted into an Arc set for each CMF along with the corresponding percent flows.

OUTPUT: The Arc set produced is in the form of triplets: (t, s, p), where t is the terminal node number, s is the source node number and p is the percent flow from s to t. Also the CMF set is augmented by setting the total number of arcs for each CMF.

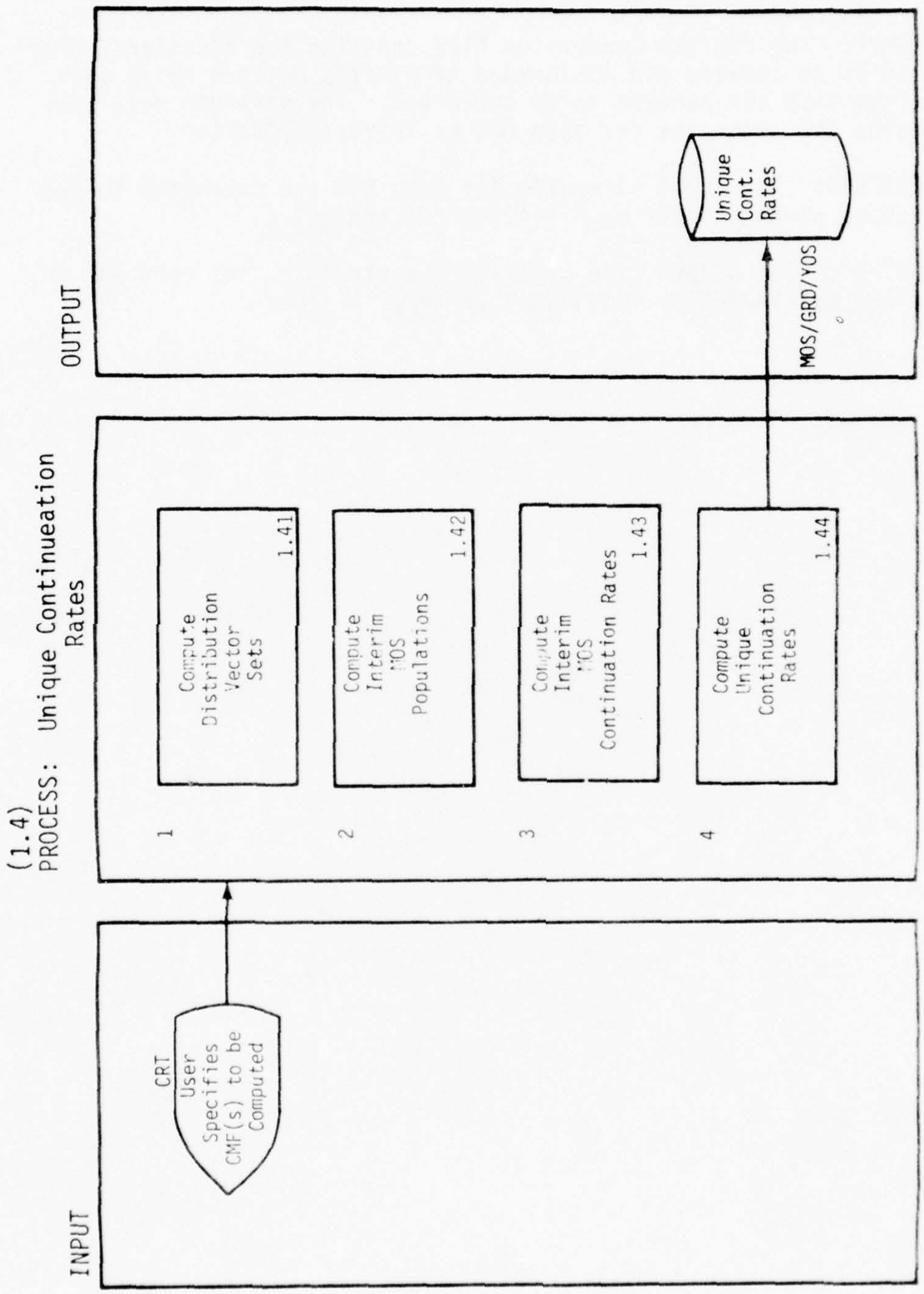

INPUT
PIA/YOS Def.
MOS Conversion File
by
MOS/GRD/Percent
MOS-Strength Data
by
YOS/Grade/Qtr
(1.3)
PROCESS: MOS Conversion File
Convert Current
MOS/Grade/YOS
Strength Data to
PIA/YOS Defined
MOS/Grade/YOS
OUTPUT
Modified MOS
Strength-Data
by
YOS/Grade/Qtr.

EXTENDED NARRATIVE FOR HIPO C-II-10

INPUT: The PIA/YOS Conversion file contains the necessary information to convert old MOS/Grades to PIA/YOS defined MOS/Grades along with the percent to be converted. The strength data contains the strengths for each MOS by YOS/Grade/Quarter.

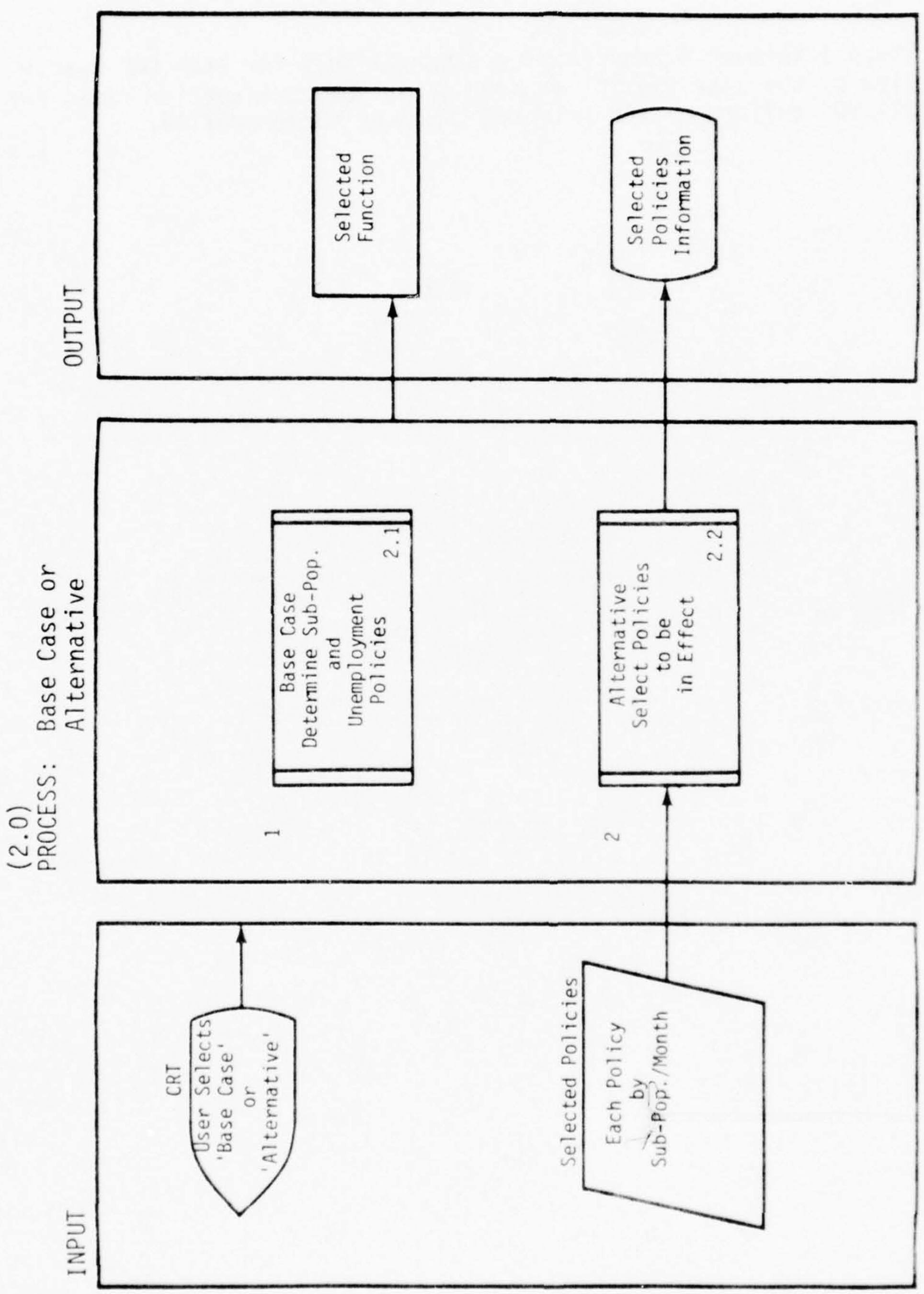
PROCESS: The input strengths for each MOS are converted to the output strengths for each PIA/YOS defined MOS.

OUTPUT: The output file contains the strengths for each MOS defined by PIA/YOS by YOS/Grade/Quarter.


INPUT
CRT
User Specifies CMF(s) to be Computed
(1.4)
PROCESS: Unique Continueation Rates
1
Compute Distribution Vector Sets
1.41
2
Compute Interim MOS Populations
1.42
3
Compute Interim MOS Continuation Rates
1.43
4
Compute Unique Continuation Rates
1.44
OUTPUT
MOS/GRD/YOS
Unique Cont. Rates

EXTENDED NARRATIVE FOR HIPO C-II-12

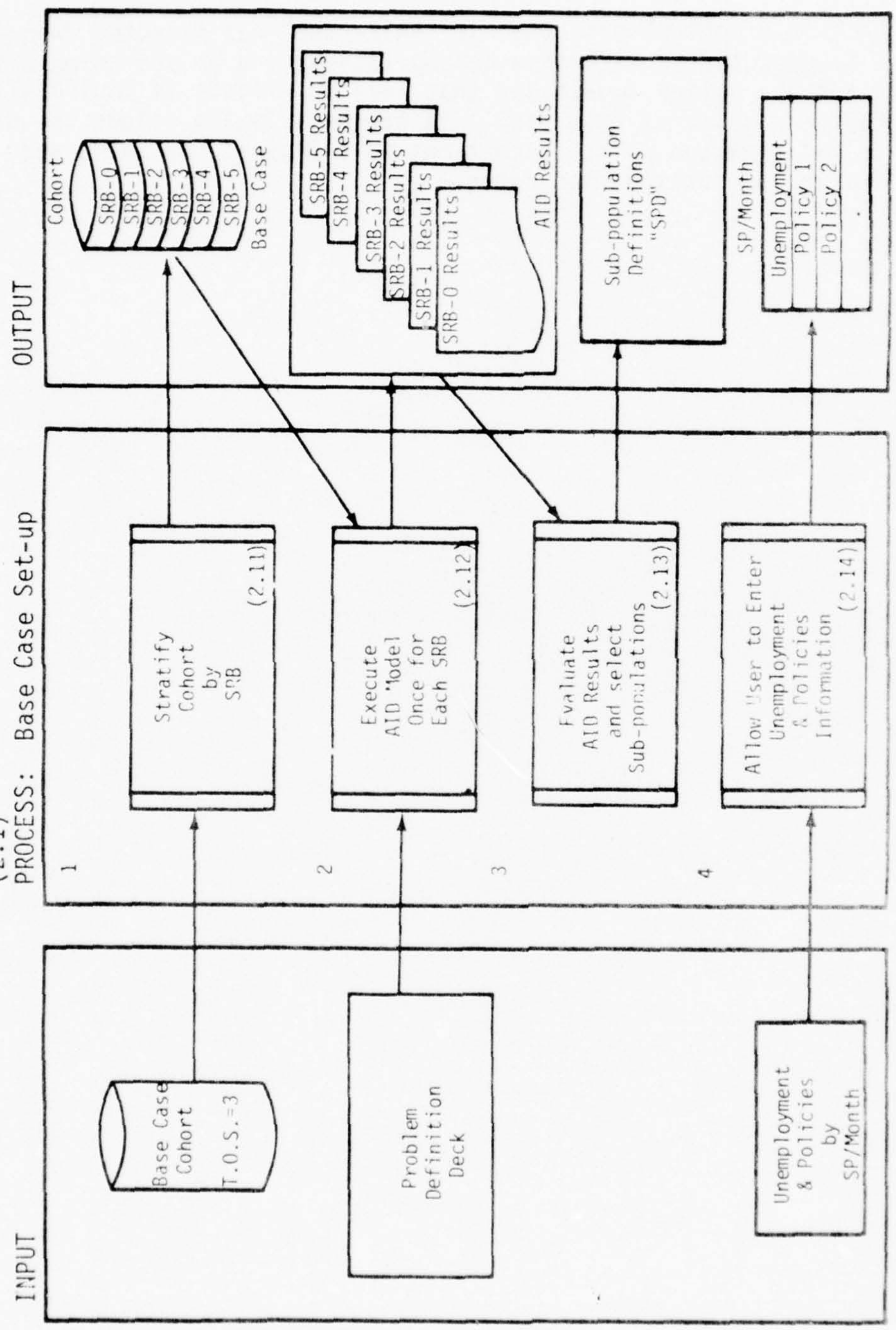
Steps 1 through 4 are executed interactively for each CMF specified by the user via CRT to produce unique continuation rates for all MOS defined by the selected CMF's by MOS/Grade/YOS.



INPUT
CRT
User Selects
'Base Case'
or
'Alternative'
Selected Policies
Each Policy
by
Sub-Pop./Month
(2.0)
PROCESS: Base Case or
Alternative
1
Base Case
Determine Sub-Pop.
and
Unemployment
Policies
2.1
2
Alternative
Select Policies
to be
in Effect
2.2
OUTPUT
Selected
Function
Selected
Policies
Information

EXTENDED NARRATIVE FOR HIPO C-II-14

This is a control process: if "BASE-CASE" was selected then step 1 is executed to determine subpopulations and to set unemployment rates and policy conditions that were in effect; if "ALTERNATIVE" had been selected then step 2 is executed, which allows the user to set expected policy conditions to influence the third and fourth YOS continuation rates.


INPUT
(2.1)
PROCESS: Base Case Set-up
OUTPUT
Base Case Cohort T.O.S.=3
Problem Definition Deck
Unemployment & Policies by SP/Month
1
2
3
4
Stratify Cohort by SRB (2.11)
Execute AID Model Once for Each SRB (2.12)
Evaluate AID Results and select Sub-populations (2.13)
Allow User to Enter Unemployment & Policies Information (2.14)
Cohort
SRB-0
SRB-1
SRB-2
SRB-3
SRB-4
SRB-5
Base Case
SRB-5 Results
SRB-4 Results
SRB-3 Results
SRB-2 Results
SRB-1 Results
SRB-0 Results
AID Results
Sub-population Definitions "SPD"
SP/Month
Unemployment
Policy 1
Policy 2

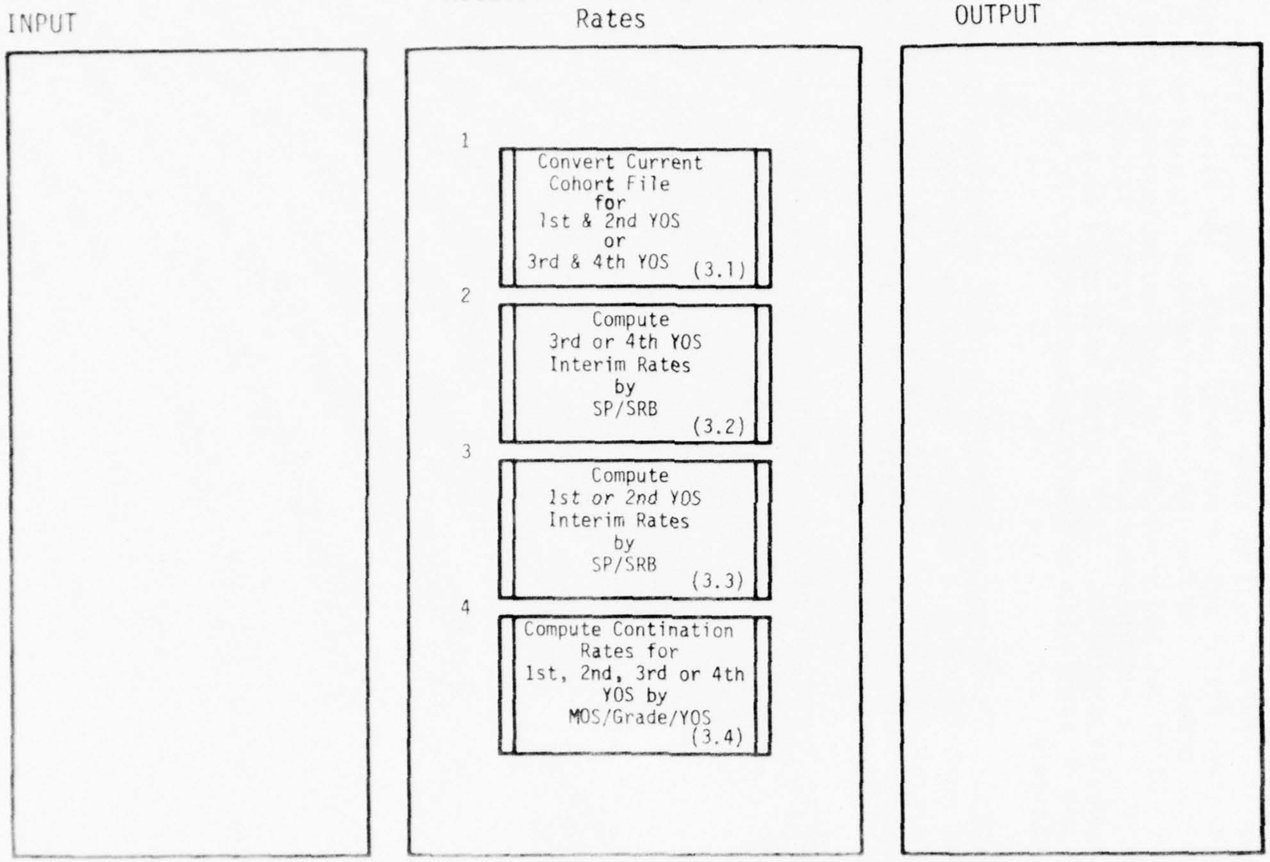
EXTENDED NARRATIVE FOR HIPO C-II-16

INPUT: The "Base Case Cohort" describes those individuals with term of service equal to three and who belong to the cohort which is current fiscal year minus three years. The file is in MOS ascending order. The Problem Definition Deck" is used to define the range of values and groupings for each variable used by the AID model. The unemployment rates and the policy indicators are by subpopulations/month. Each policy is treated as a binary variable (a one or zero) used to indicate that a Policy is on or off respectively.

PROCESS: The "Base Case Cohort" is first stratified by SRB and then each SRB file is used as input to the AID model. The user then evaluates the AID results and selects the subpopulations to be used. With the subpopulations defined the unemployment rates and Policies can be entered.

OUTPUT: Unemployment rates and Policies by subpopulations/month.

(3.0)
PROCESS: First Term Continuation Rates



EXTENDED NARRATIVE FOR HIPO C-II-18

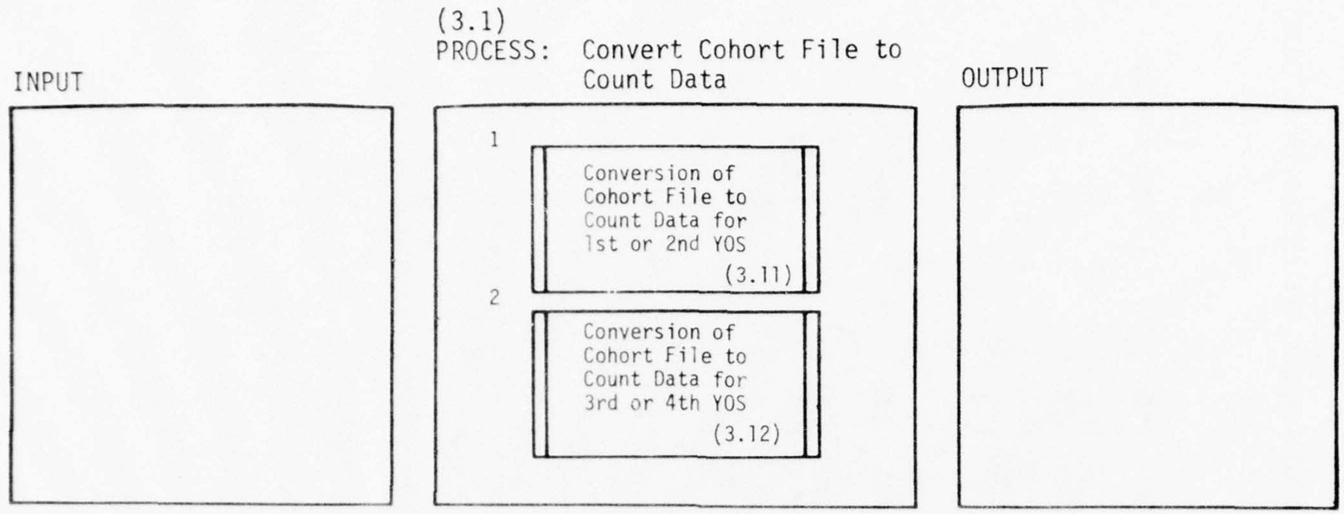
This is a control process used to support either the "BASE CASE" or "ALTERNATIVE":

"BASE CASE"

Pass	Cont. Rate	Steps Executed
1	3rd YOS	1, 2 & 4
2	4th YOS	1, 2, & 4
3	1st YOS	1, 3, & 4
4	2nd YOS	1, 3, & 4

"ALTERNATIVE"

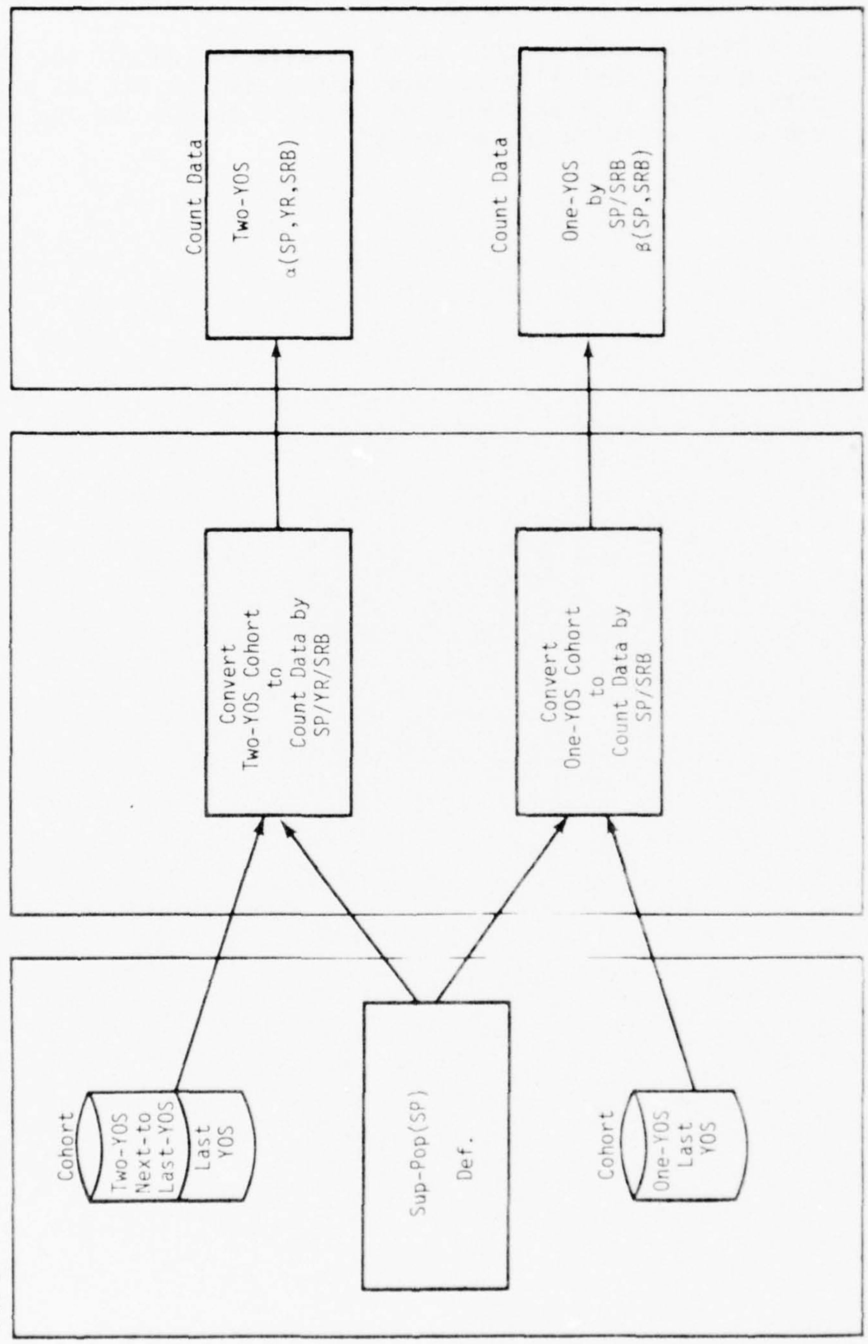
Pass	Cont. Rate	Steps Executed
1	3rd YOS	2 & 4
2	4th YOS	2 & 4
3	N/A	N/A
4	N/A	N/A


INPUT
(3.1)
PROCESS: Convert Cohort File to Count Data
OUTPUT
1
Conversion of Cohort File to Count Data for 1st or 2nd YOS
(3.11)
2
Conversion of Cohort File to Count Data for 3rd or 4th YOS
(3.12)

EXTENDED NARRATIVE FOR HIPO C-II-20

This is a control process which is used to control the conversion of a given Cohort file to count data based on the YOS being computed. Step 1 is executed for first or second YOS and Step 2 is executed for third or fourth YOS.

(3.11)
PROCESS: Conversion of Cohort File to Count Data for 1st or 2d YOS

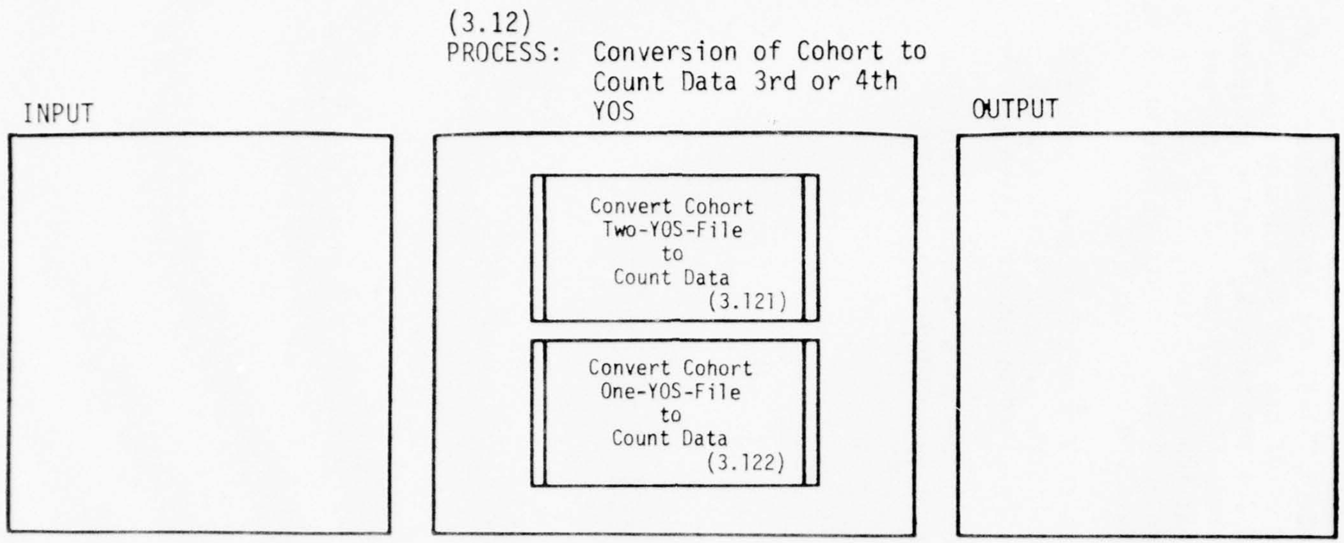


EXTENDED NARRATIVE FOR HIPO C-II-22

INPUT: There are two input Cohort files, one has one Year of Service (YOS) information and the other has two YOS information. The one YOS Cohort has as its last YOS the current FY being projected. The two-YOS Cohort has the current FY minus one and the current FY as its next to last YOS and last YOS respectively. In addition to the Cohort Files there is a Subpopulation Definition file which is used to stratify the count data along with the SRB.

PROCESS: The two YOS Cohort is transformed into count data and the FY are separated and stratified by sub-population and SRB. The one YOS Cohort is simply stratified by subpopulation and SRB.

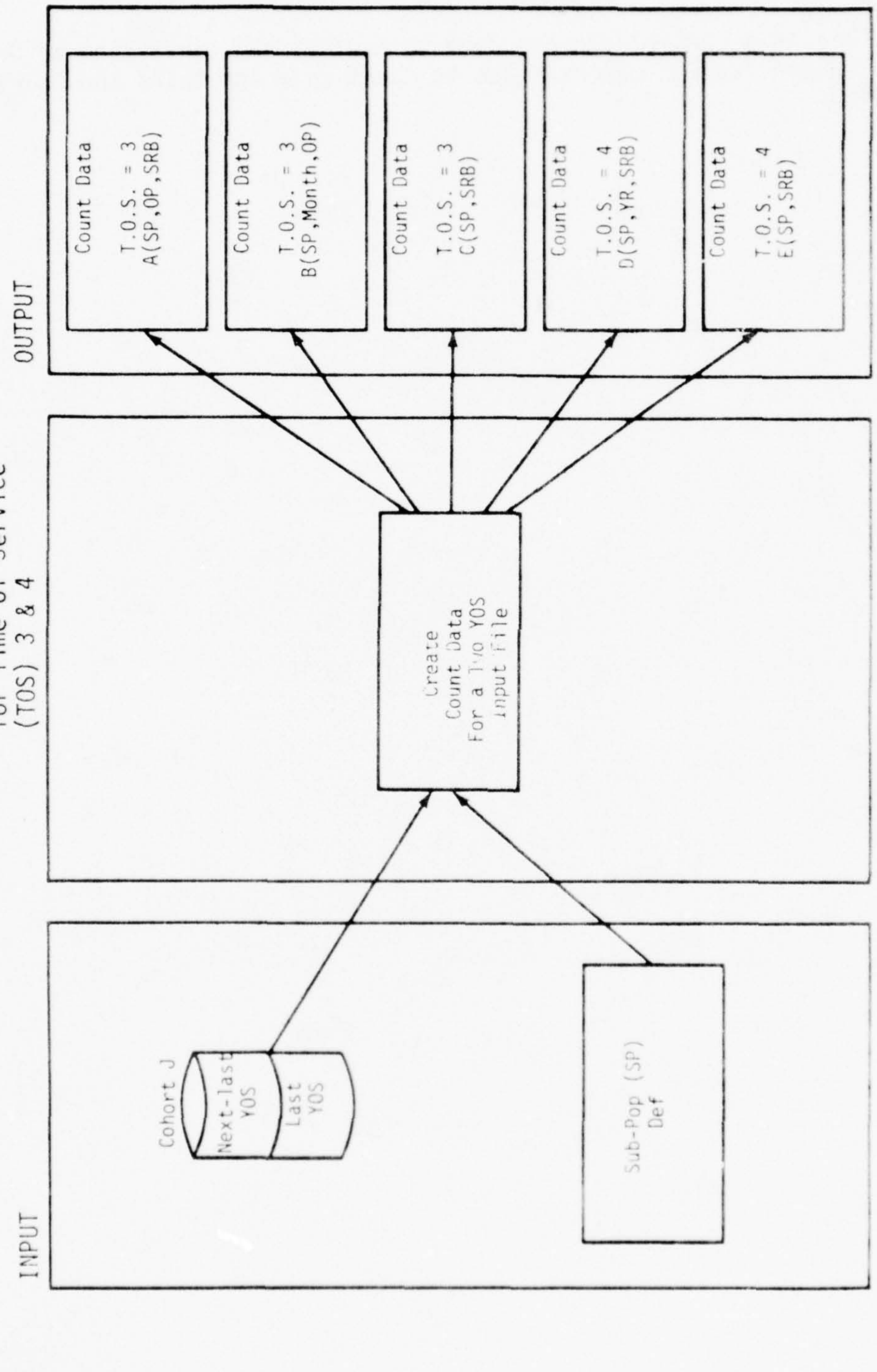
OUTPUT: Count data for two-YOS Cohort by sub-population/FY/SRB and count data for one YOS Cohort by subpopulation and SRB.


(3.12)
PROCESS: Conversion of Cohort to Count Data 3rd or 4th YOS
INPUT
OUTPUT
Convert Cohort Two-YOS-File to Count Data (3.121)
Convert Cohort One-YOS-File to Count Data (3.122)

EXTENDED NARRATIVE FOR HIPO C-II-24

This is a control process used to control the conversion of One-YOS and Two-YOS Cohort files to count data for third and fourth YOS.

(3.121)
PROCESS: Convert Two-YOS Files for Time of Service (TOS) 3 & 4



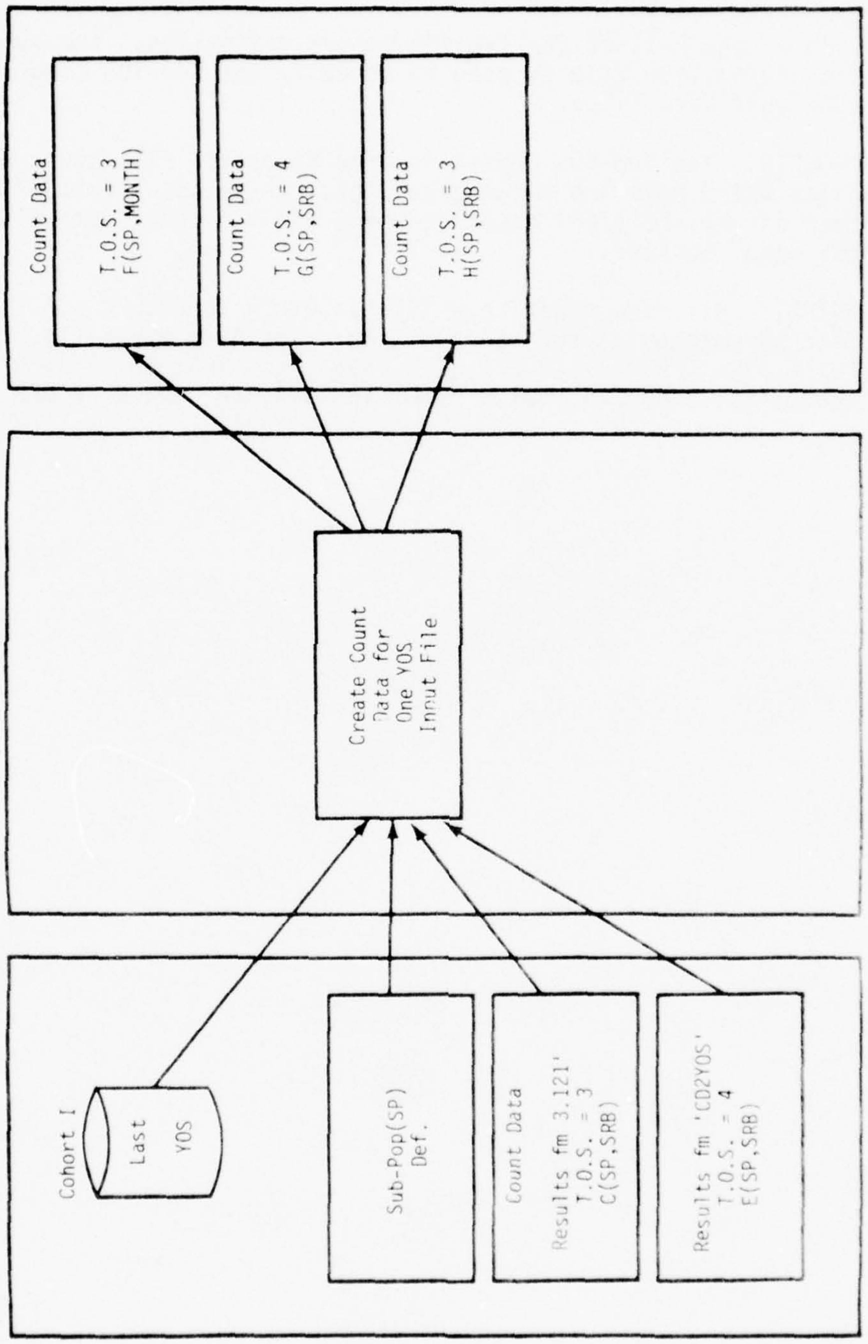
EXTENED NARRATIVE FOR HIPO C-II-26

INPUT: See C-II-22 for Two-YOS Cohort definition. The subpopulation definition file is used to stratify the Two-YOS Cohort into the Count Data Files.

PROCESS: The Two-YOS Cohort is used to create five count data files which have two major groupings. Three count data files for Term of Service (TOS) equal to three and two count data files with TOS equal to four.

OUTPUT: All five count data files, Sets A through E are stratified by subpopulation. In addition: Set A is stratified by OP (OP = 1) = (RE-UP) & (OP = 2) = (Sep) and SRB; Set B by OP and month; Set C by SRB; Set D by FY and SRB; and Set E by SRB.

(3.122)
PROCESS: Convert One-YOS Files for Time of Service (TOS) 3 & 4



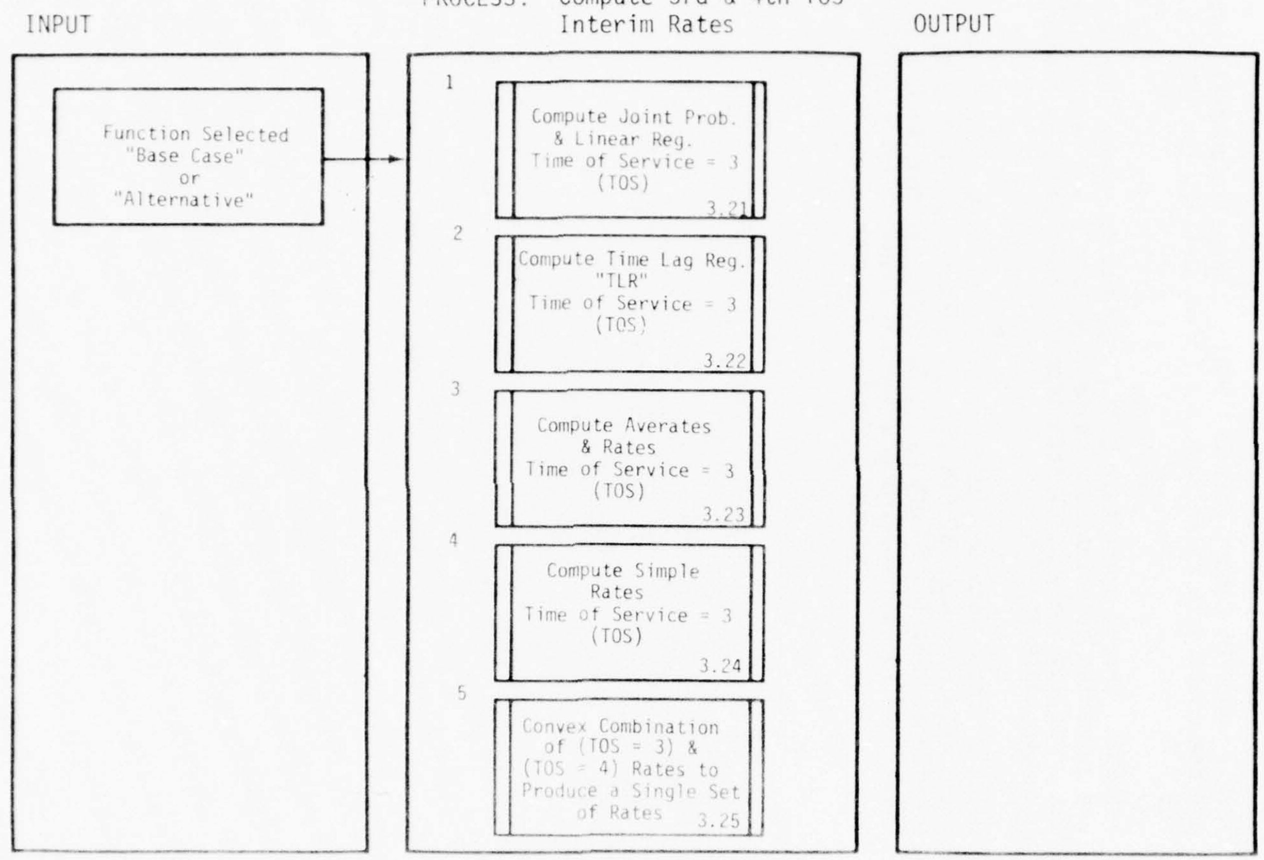
EXTENDED NARRATIVE FOR HIPO C-II-28

INPUT: One-YOS Cohort (see C-II-22), Subpopulation definitions, and the count data files Sets C & E from C-II-26 for TOS = 3 and TOS = 4.

PROCESS: Create count data Sets F, G, and H. Where Sets G & H are augmented with the count data from Sets C & E respectively. Set F reflects only count data from One-YOS Cohort by subpopulation and month for TOS = 3.

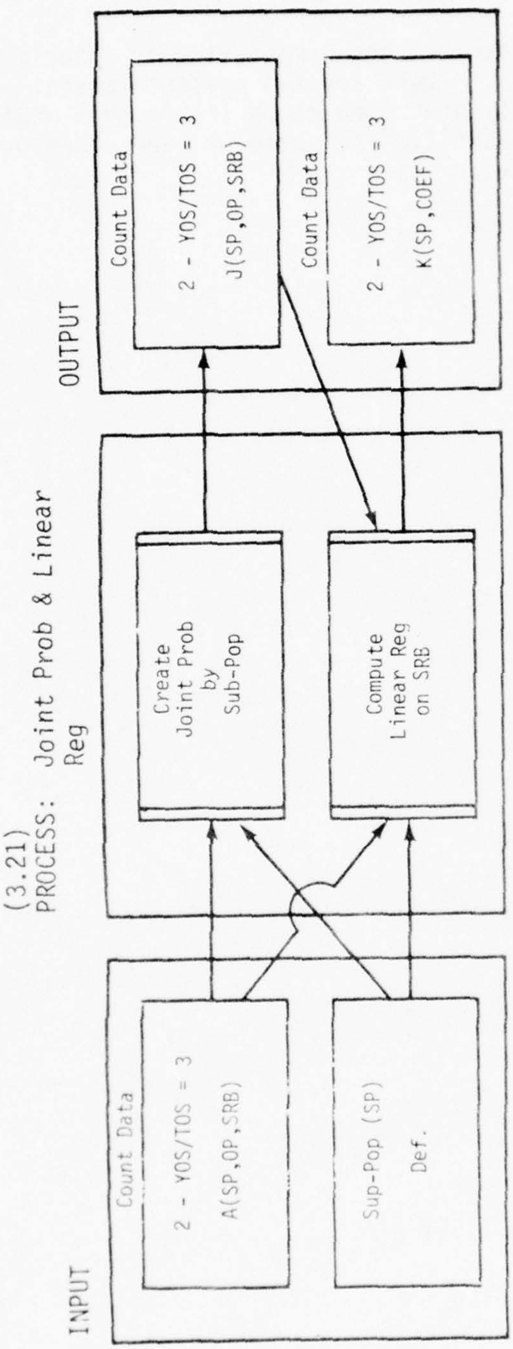
OUTPUT: Three sets of Count data: Set F which reflects only count data from One-YOS Cohort, Set G is the count data for the One-YOS and Two-YOS Cohort files for TOS = 3, and Set H is the count data for the One-YOS and Two YOS Cohort files for TOS = 4.

(3.2)
PROCESS: Compute 3rd & 4th YOS Interim Rates



EXTENDED NARRATIVE FOR HIPO C-II-30

This is a control process to control the computation of interim rates for third and fourth YOS. There are two possible cases: Case 1, "BASE CASE" selected by user then steps 1 through 5 would be executed; and Case 2, "ALTERNATIVE" selected by user, then only steps 3 and 5 would be executed.


(3.21)
PROCESS: Joint Prob & Linear Reg
INPUT
Count Data
2 - YOS/TOS = 3
A(SP,OP,SRB)
Sup-Pop (SP)
Def.
Create
Joint Prob
by
Sub-Pop
Compute
Linear Reg
on SRB
OUTPUT
Count Data
2 - YOS/TOS = 3
J(SP,OP,SRB)
Count Data
2 - YOS/TOS = 3
K(SP,COEF)

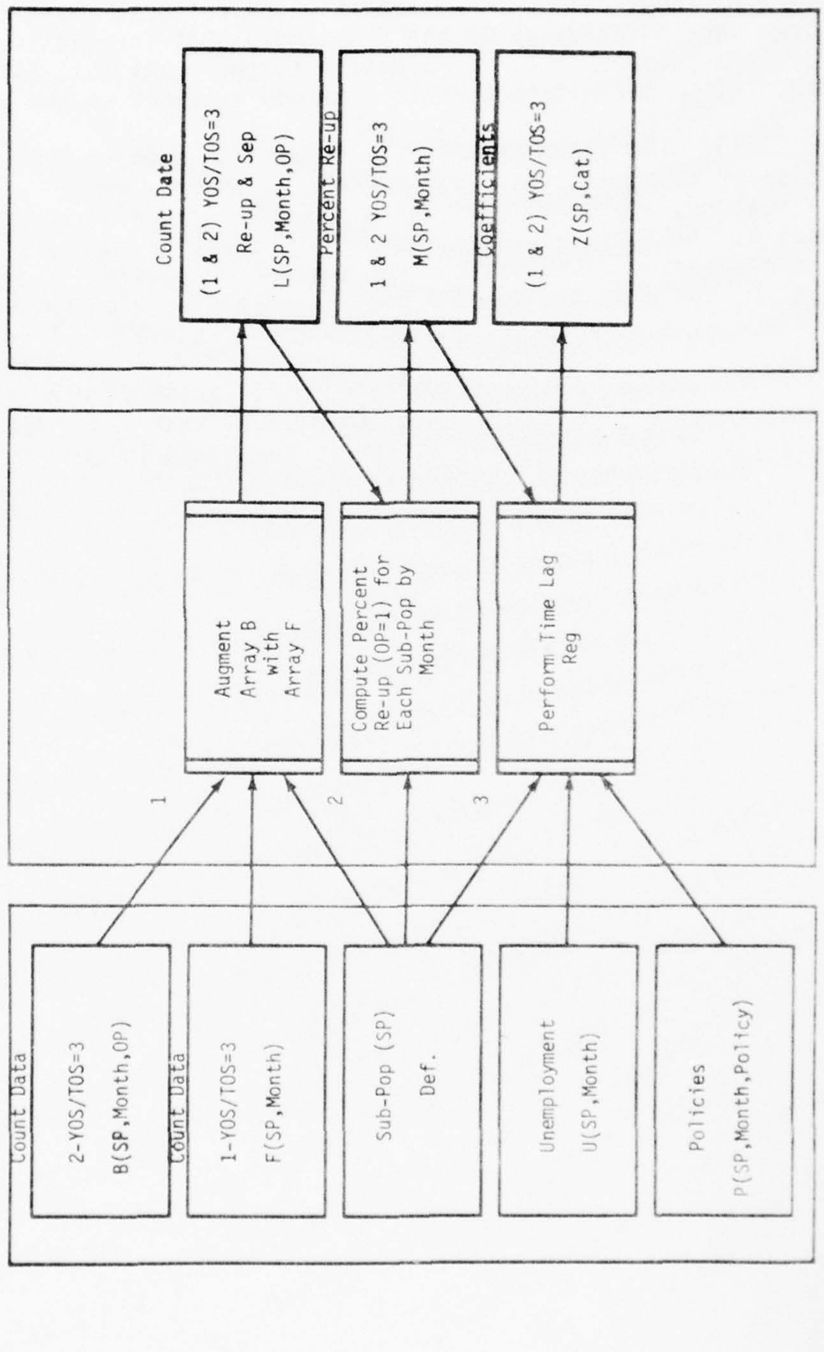
EXTENDED NARRATIVE FOR HIPO C-II-32

INPUT: Count data from C-II-25 A which reflects count data for each subpopulation by OP and SRB, where OP=1 for reenlistments and OP=2 for separations. In addition to the count data file a subpopulation definition file is provided as input to the process.

PROCESS: The joint probability is used to compute the distribution of subpopulations with respect to OP (RE-UP/Sep) and SRB. A linear regression is then performed using the distributions from set A. If a distribution, due to its size, is to small then the corresponding distribution from the Set J is used. The resulting Set K, contains the a and b coefficiences for each subpopulation, (i.e., a_1+b_1x, $a_2+b_2, \ldots, a_k+b_k$), where X is the SRB level.

OUTPUT: Set J is an intermediate result which is used only if a distribution from Set A is to small, less than 100. The final results of the linear regression is contained in Set K by subpopulation/coef, where [(coef=1) for a] and [(coef=2) for b].

(3.22)
PROCESS: Time Lag Reg. Time of Service (TOS) = 3



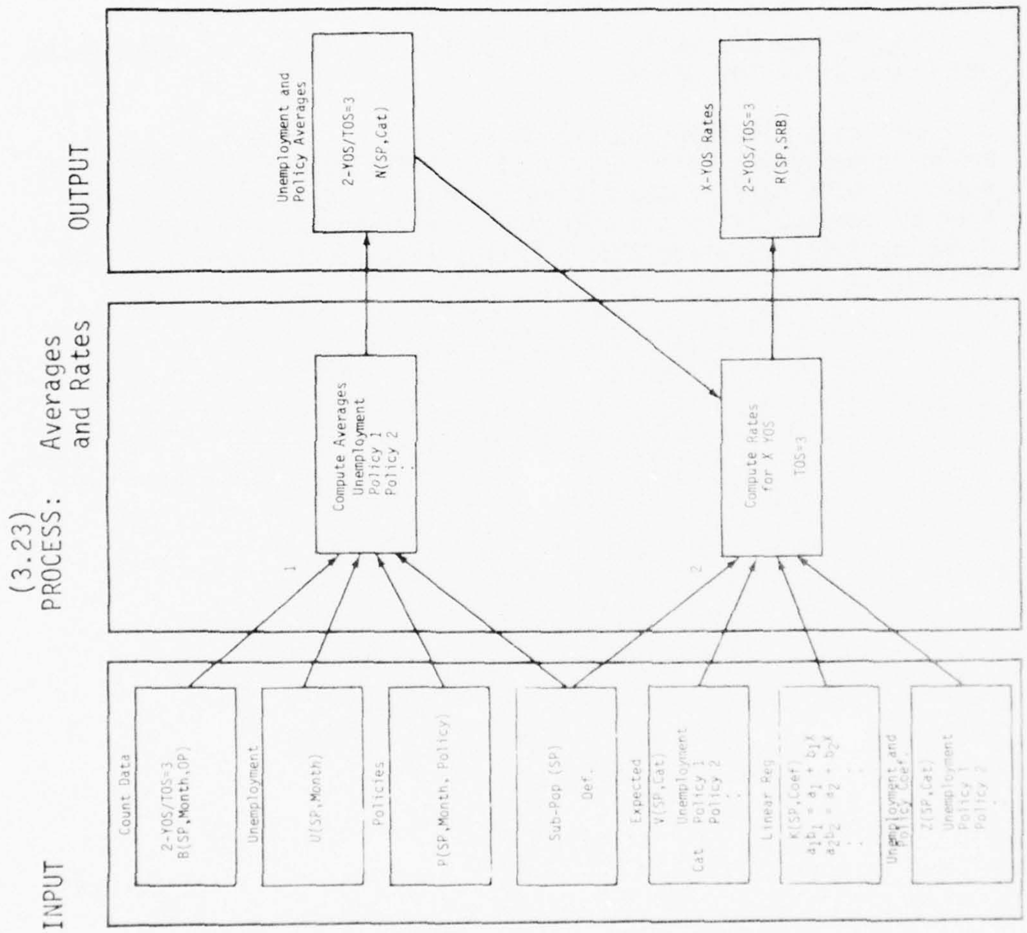
EXTENDED NARRATIVE FOR HIPO C-II-34

This process performs three functions:

1. The RE-UP component (OP=1) for Set B is augmented with the RE-UP count from Set F for each subopulation by month (month=1,2..., 12).

2. Compute the percent Re-up for each subopulation by month using Set L and producing Set M.

3. Perform a Time Lag Regression on: Re-up/Unemployment/Policy1/.../Policy k for each subpopulation by month, resulting in a coefficient matrix Z. Matrix Z is stratified by subpopulation and category, where [(category=1)= Unemployment], [(category=2) = Policy 1]...[(category=K+1) = Policy K].

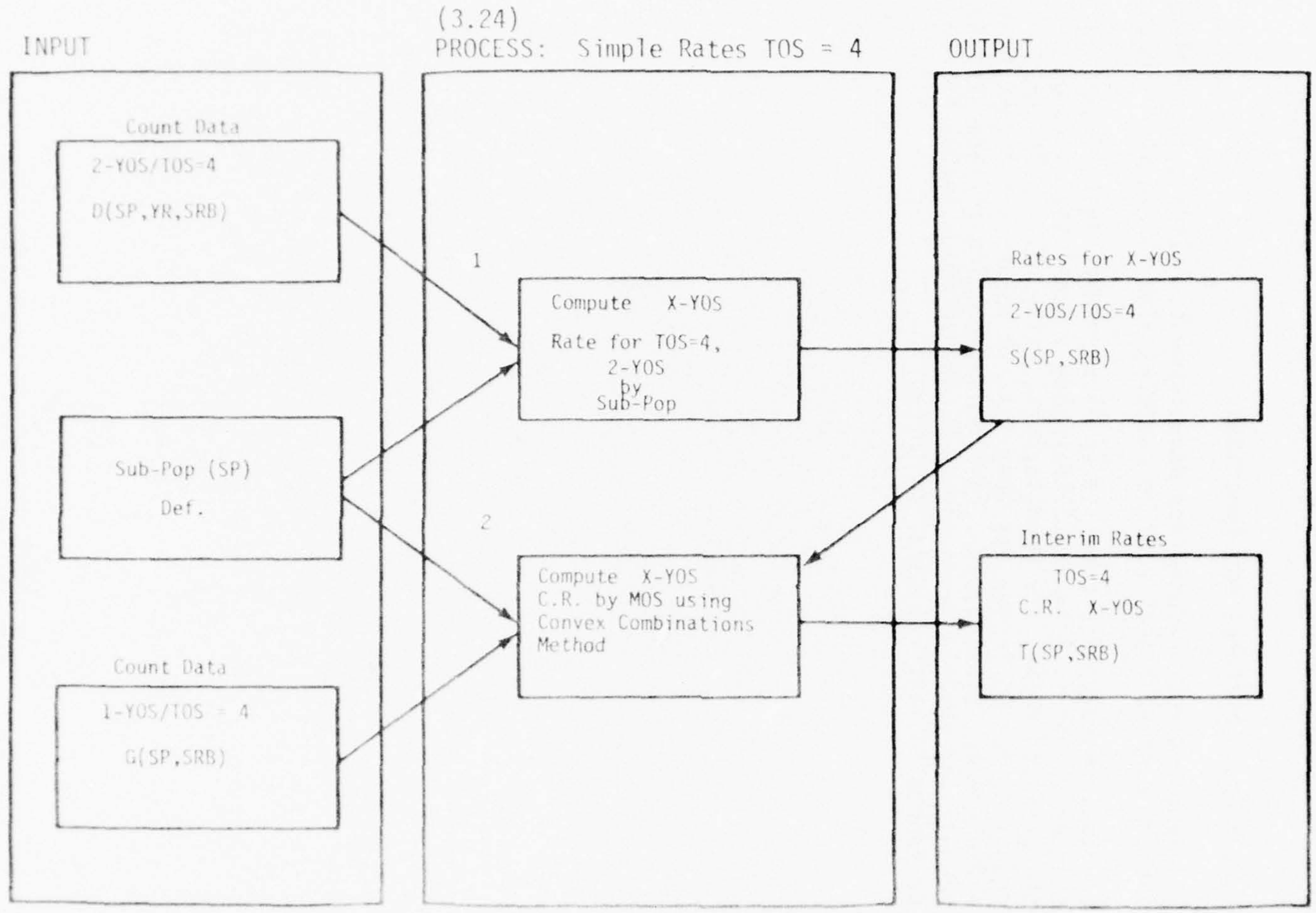

(3.23)
PROCESS: Averages and Rates
INPUT
OUTPUT
Count Data
2-YOS/TOS=3
B(SP,Month,OP)
Unemployment
U(SP,Month)
Policies
P(SP,Month, Policy)
Sub-Pop (SP)
Def.
Expected
V(SP,Cat)
Cat
Unemployment
Policy 1
Policy 2
Linear Reg
K(SP,Coef)
Unemployment and Policy Coef
Z(SP,Cat)
Unemployment
Policy 1
Policy 2
1
Compute Averages
Unemployment
Policy 1
Policy 2
2
Compute Rates for X YOS
TOS=3
Unemployment and Policy Averages
2-YOS/TOS=3
N(SP,Cat)
X-YOS Rates
2-YOS/TOS=3
R(SP,SRB)

EXTENDED NARRATIVE FOR HIPO C-II-36

This process performs two functions:

1. Averages are computed for Unemployment, Policy 1,..., Policy k for the current fiscal year be computed with TOS equal to three.

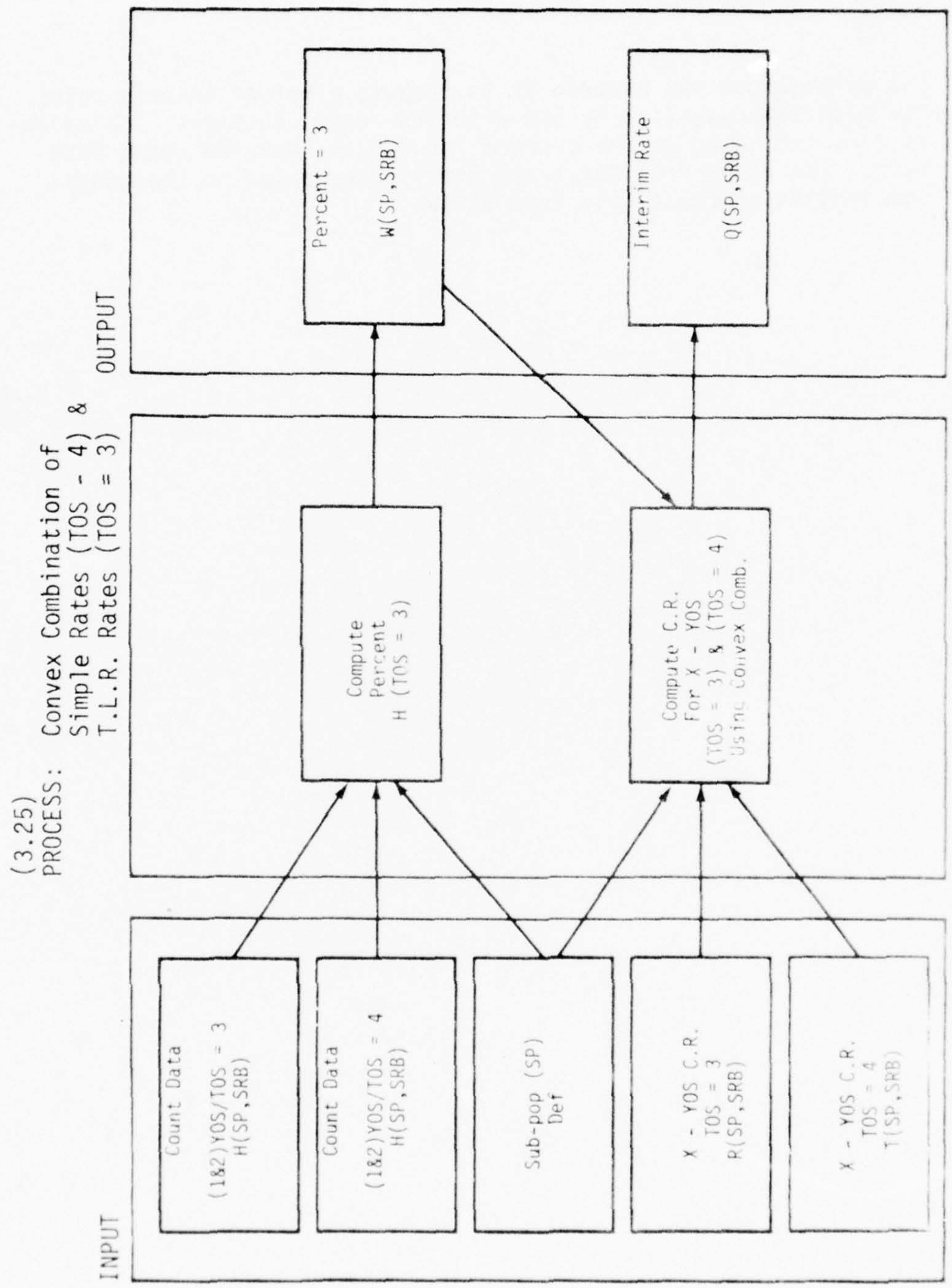
2. Interim rates are computed by first modifying the coefficiences in matrix Z by the differences between the averages and the expected values for unemployment, policy 1,..., Policy k. The resulting coefficiences are then used to adjust the intercept (coefficient a_i, for i=1,2,...,k) from Set k which is then used to compute the interim rates for each subpopulation by SRB for third or fourth YOS and TOS equal to three.



(3.24)
INPUT
PROCESS: Simple Rates TOS = 4
OUTPUT
Count Data
2-YOS/TOS=4
D(SP,YR,SRB)
Sub-Pop (SP)
Def.
Count Data
1-YOS/TOS = 4
G(SP,SRB)
1
Compute X-YOS
Rate for TOS=4,
2-YOS
by
Sub-Pop
2
Compute X-YOS
C.R. by MOS using
Convex Combinations
Method
Rates for X-YOS
2-YOS/TOS=4
S(SP,SRB)
Interim Rates
TOS=4
C.R. X-YOS
T(SP,SRB)

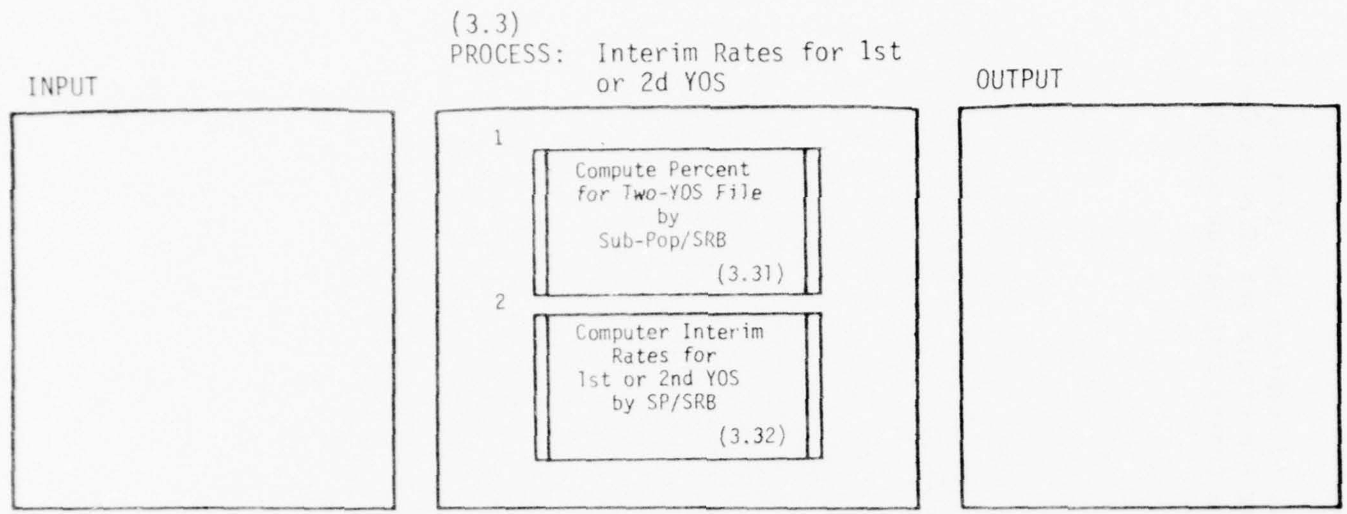
EXTENDED NARRATIVE FOR HIPO C-II-38

The purpose for the process is to compute a set of interim rates for each subpopulation by SRB with TOS equal to four. The calculations are based on the current Two-YOS and One-YOS count data sets. The rates from Set S are distributed based on the convex combination of count data from Set G.


(3.25)
PROCESS: Convex Combination of Simple Rates (TOS - 4) & T.L.R. Rates (TOS = 3)
INPUT
Count Data (1&2)YOS/TOS = 3 H(SP,SRB)
Count Data (1&2)YOS/TOS = 4 H(SP,SRB)
Sub-pop (SP) Def
X - YOS C.R. TOS = 3 R(SP,SRB)
X - YOS C.R. TOS = 4 T(SP,SRB)
Compute Percent H (TOS = 3)
Compute C.R. For X - YOS (TOS = 3) & (TOS = 4) Using Convex Comb.
OUTPUT
Percent = 3 W(SP,SRB)
Interim Rate Q(SP,SRB)

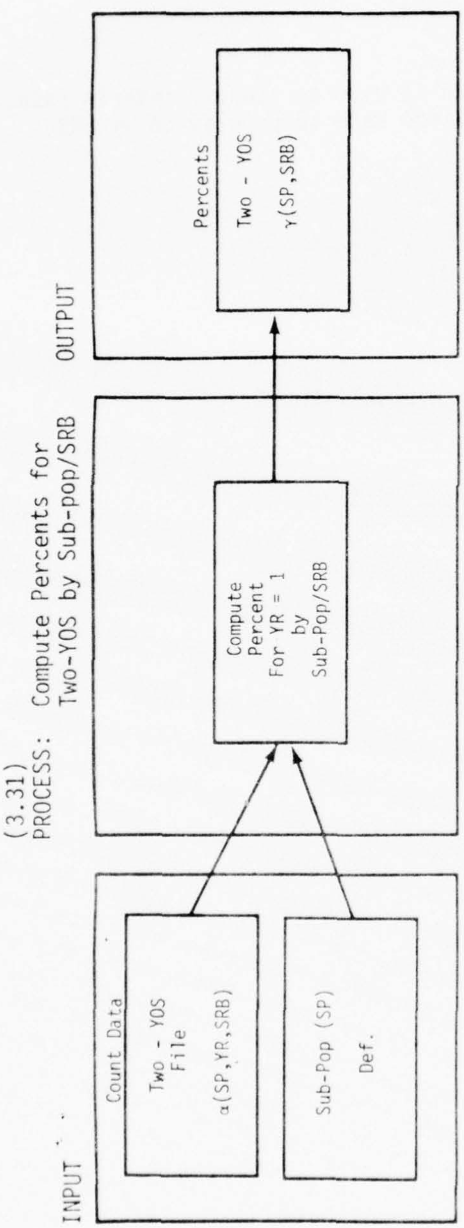
EXTENDED NARRATIVE FOR HIPO C-II-40

The purpose for this process is to combined the rates for TOS equal to three and four to obtain a single set of rates for each subpopulation by SRB, using the convex combination method.


(3.3)
PROCESS: Interim Rates for 1st or 2d YOS
INPUT
OUTPUT
1
Compute Percent for Two-YOS File by Sub-Pop/SRB
(3.31)
2
Computer Interim Rates for 1st or 2nd YOS by SP/SRB
(3.32)

EXTENDED NARRATIVE FOR HIPO C-II-42

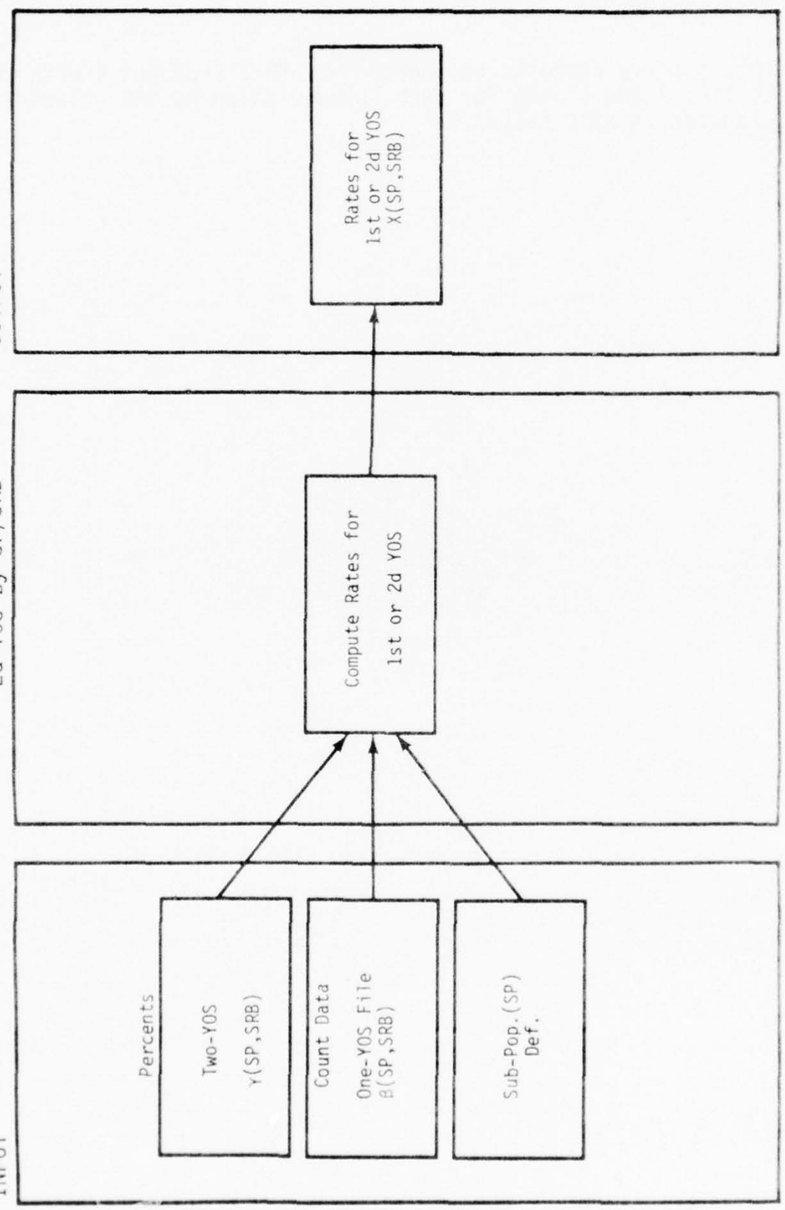
This is a control process which is used to compute interim rates for either first or second YOS for each subpopulation by SRB.


(3.31)
PROCESS: Compute Percents for Two-YOS by Sub-pop/SRB
INPUT
Count Data
Two - YOS File
α(SP,YR,SRB)
Sub-Pop (SP) Def.
Compute Percent For YR = 1 by Sub-Pop/SRB
OUTPUT
Percents
Two - YOS
γ(SP,SRB)

EXTENDED NARRATIVE FOR HIPO C-II-44

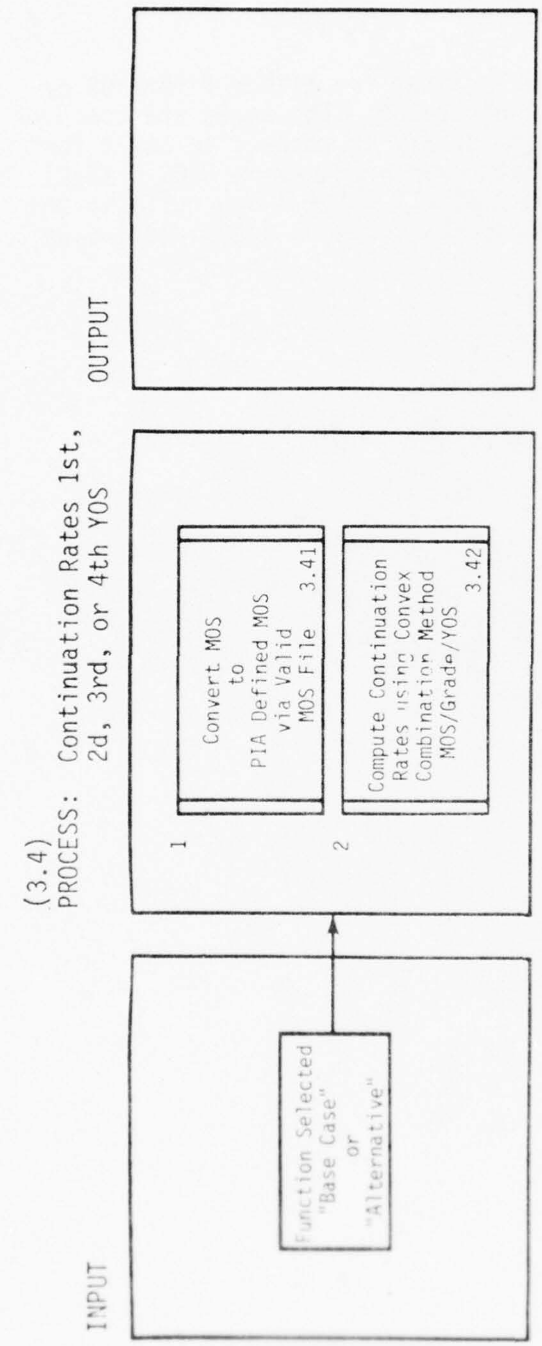
This process computes the percent of YR=1 from Set X with respect to (YR=1) and (YR=2) for each subpopulation by SRB. (Set X was produced in HIPO C-II-21).

(3.32)
PROCESS: Simple Rates for 1st or 2d YOS by SP/SRB



EXTENDED NARRATIVE FOR HIPO C-II-46

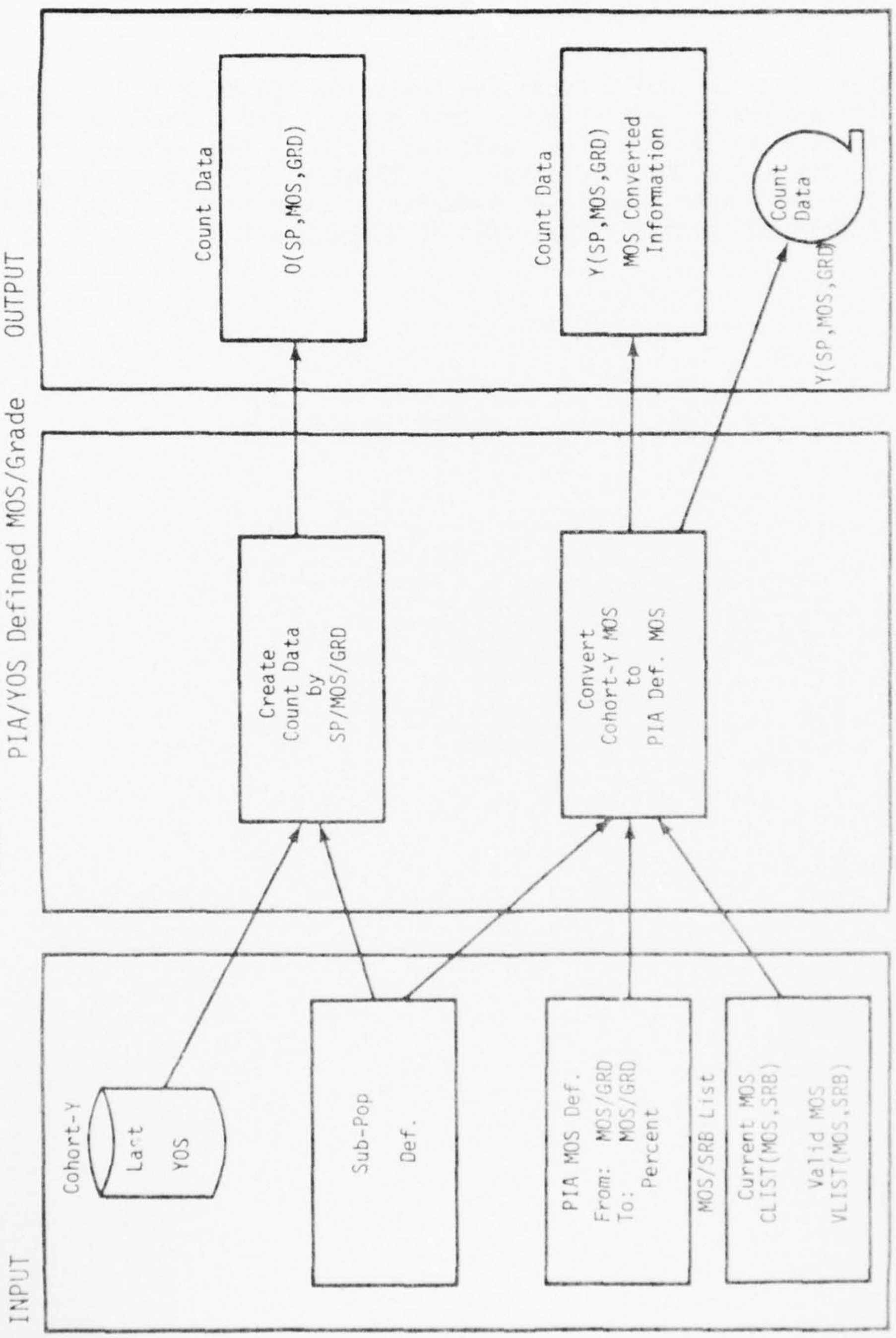
This process computes the interim rates for either first YOS or second YOS for each subpopulation by SRB. The rates are computed by taking the convex combination of X with respect to Set B for each subpopulation by SRB. (Set B was produced in HIPO C-II-21 and Set X was produced in HIPO C-II-43). Set X now reflects the interim rates for first or second YOS for each subpopulation by SRB.


INPUT
Function Selected
"Base Case"
or
"Alternative"
(3.4)
PROCESS: Continuation Rates 1st, 2d, 3rd, or 4th YOS
1
Convert MOS
to
PIA Defined MOS
via Valid
MOS File
3.41
2
Compute Continuation
Rates using Convex
Combination Method
MOS/Grade/YOS
3.42
OUTPUT

EXTENDED NARRATIVE FOR HIPO C-II-48

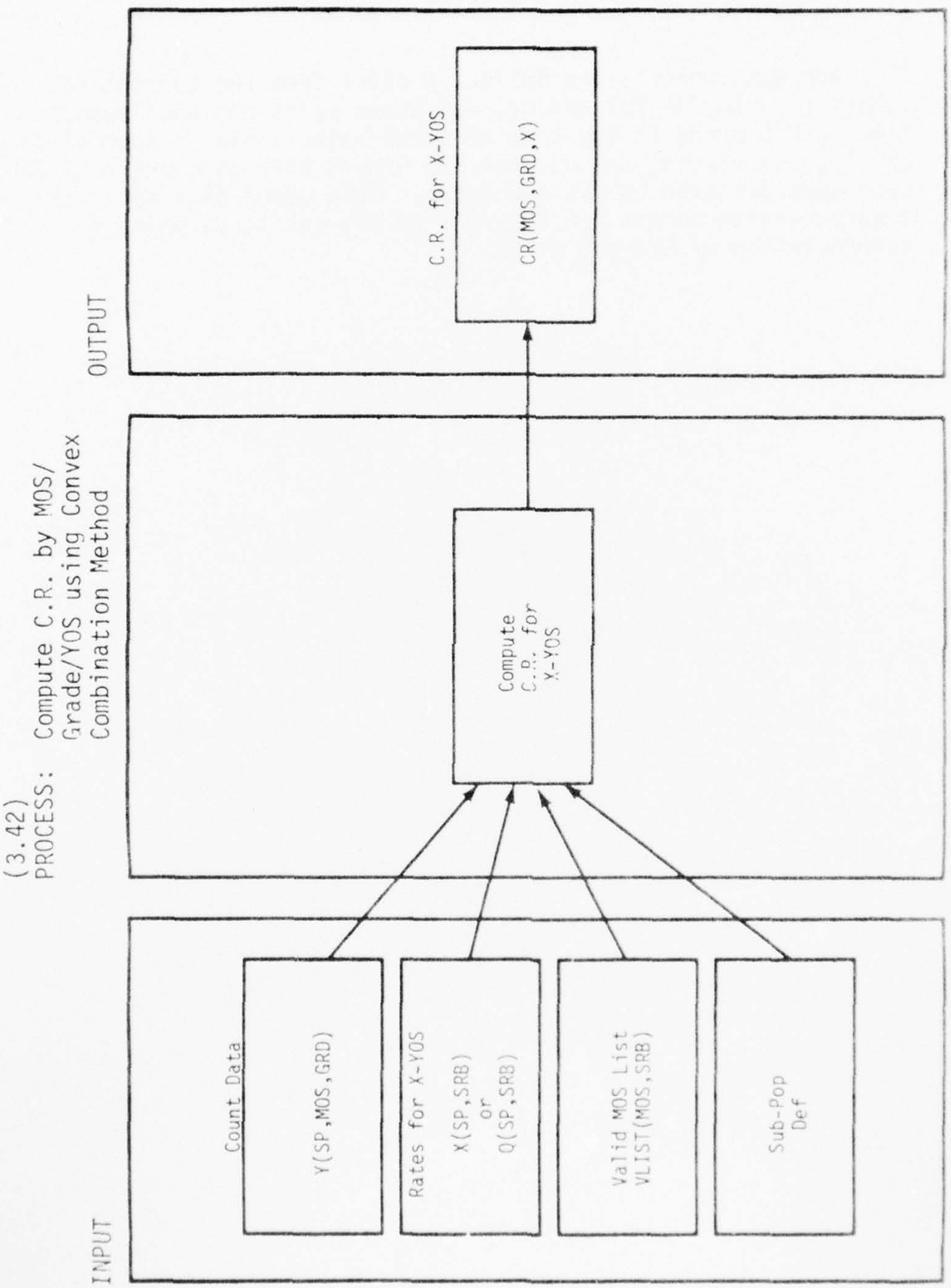
This is a control process for computing YOS continuation rates. If "BASE-CASE" was selected then steps 1 and 2 would be executed to compute continuation rates for either first, second, third, or fourth YOS by MOS/Grade/YOS. If "ALTERNATIVE" had been selected then only step 2 would be executed to compute either third or fourth YOS continuation rates by MOS/Grade/YOS.

(3.41)
PROCESS: Convert MOS/Grade to PIA/YOS Defined MOS/Grade



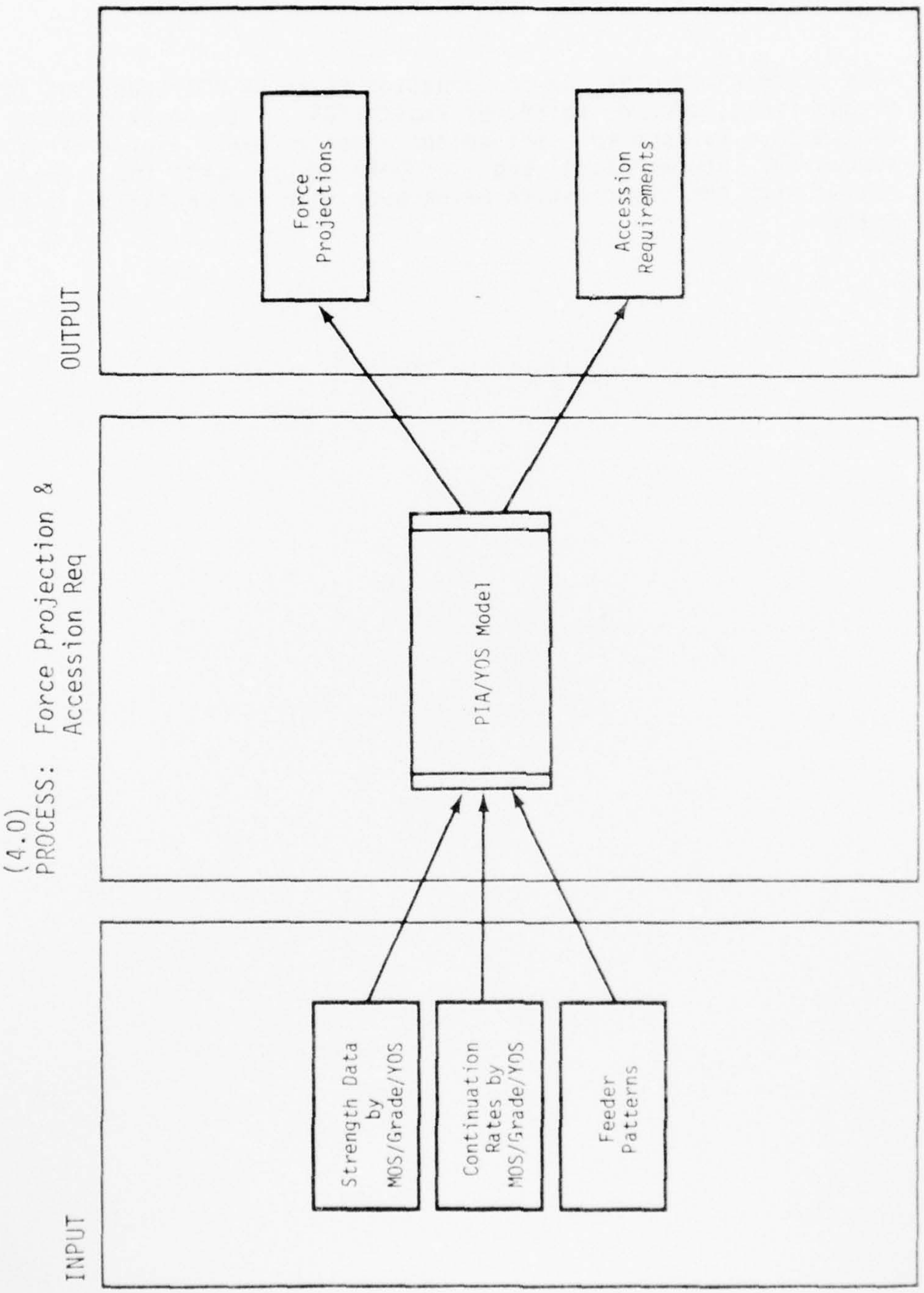
EXTENDED NARRATIVE FOR HIPO C-II-50

This process converts the MOS/Grade pairs from the current YOS cohort file to PIA/YOS defined Mos/Grade pairs for each subpopulation by MOS/Grade in the form of count data. This is accomplished by first converting the current YOS Cohort file to count data for each subpopulation by MOS and grade. This count data Set 0 is then converted to the PIA/YOS defined MOS and grade pairs for each subpopulation by MOS and grade.


(3.42)
PROCESS: Compute C.R. by MOS/
Grade/YOS using Convex
Combination Method
INPUT
Count Data
Y(SP,MOS,GRD)
Rates for X-YOS
X(SP,SRB)
or
Q(SP,SRB)
Valid MOS List
VLIST(MOS,SRB)
Sub-Pop
Def
Compute
C.R. for
X-YOS
OUTPUT
C.R. for X-YOS
CR(MOS,GRD,X)

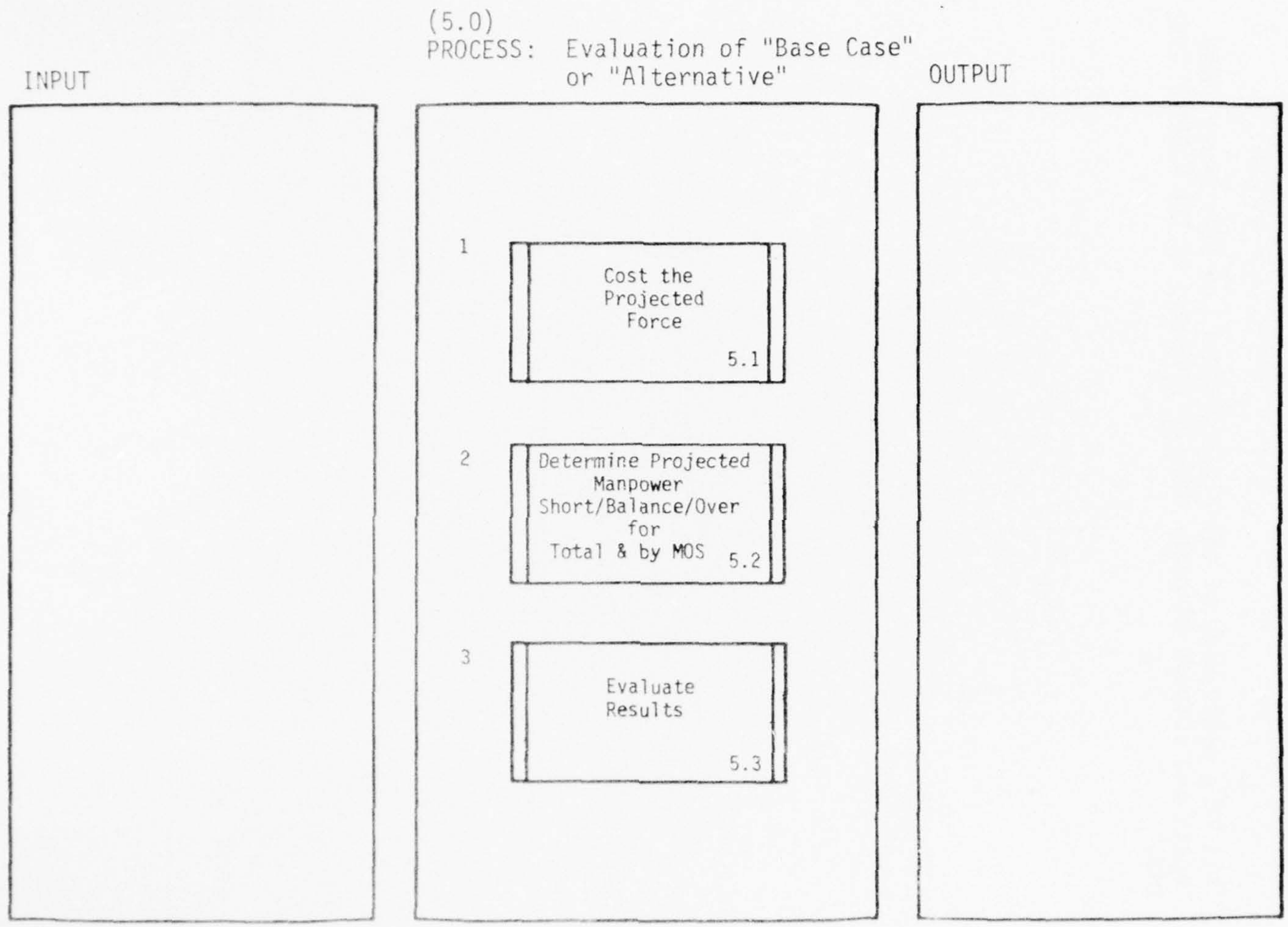
EXTENDED NARRATIVE FOR HIPO C-II-52

- This process computes the continuation rates by MOS/Grade/YOS for either first, second, third, or fourth YOS. The convex combination method is used to combined the interim rates, (Set X first or second YOS interim rates) and (Set 0 third or fourth YOS interim rates) with the distribution being over each subpopulation by MOS/Grade.


(4.0)
PROCESS: Force Projection & Accession Req
INPUT
Strength Data by MOS/Grade/YOS
Continuation Rates by MOS/Grade/YOS
Feeder Patterns
PIA/YOS Model
OUTPUT
Force Projections
Accession Requirements

EXTENDED NARRATIVE FOR HIPO C-II-54

This is a macro view of the PIA/YOS Model and only shows those inputs and outputs directly used or produced by the CEABREP system.


(5.0)
PROCESS: Evaluation of "Base Case" or "Alternative"
INPUT
OUTPUT
1
Cost the Projected Force
5.1
2
Determine Projected Manpower Short/Balance/Over for Total & by MOS
5.2
3
Evaluate Results
5.3

EXTENDED NARRATIVE FOR HIPO C-II-56

This process performs three functions:

1. It allows the user the ability to cost the projected force.

2. Determine projected manpower shortages, balances, and overages for each MOS and the total force.

3. Assist in the evaluation process to determine if another alternative is required.

APPENDIX D

CONTINUATION RATES FOR THE MANEUVER COMBAT ARMS

D-1. BACKGROUND. This Appendix provides an example of MOS-unique continuation rates for the maneuver combat arms (CMF11). As explained in Chapter 3, continuation rates are probabilities that individuals in service will continue in service at least one more year. The methodology used to compute MOS-unique continuation rates for the career force at the MOS, grade and year of service level of detail is explained in Chapter 3 with a more rigorous explanation provided in CAA Technical Paper 77-3.*

D-2. THE MANEUVER COMBAT ARMS. Continuation rates were calculated using eight quarters of data which spanned the period from Jun 75 to Mar 77. The continuation rates for the maneuver combat arms are shown in Tables D-1 through D-5. Because the methodology of Chapter 3 is highly dependent on the feeder patterns of the Personnel Inventory Analysis/Year of Service model (PIA/YOS), it is possible for the computed rates to exceed one. When the rates exceed one, it is an indication that during the time span of the data there were MOS reclassifications (voluntary and involuntary) constituting unexplained personnel flows into the MOS.

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*US Army Concepts Analysis Agency, "Derivation of MOS-Unique Continuation Rates," Technical Paper CAA-TP-77-3, Bethesda, MD, Apr 77.

Table D-1. Continuation Rates by Grade and Year of Service for MOS 11B

Year of Service	Grade E1-E3	E4	E5	E6	E7	E8	E9
1	0.848	0.848	0.848	0	0	0	0
2	0.719	0.719	0.719	0	0	0	0
3	0.868	0.668	0.668	0	0	0	0
4	0.711	0.711	0.711	0	0	0	0
5	0.902	0.902	0.902	0	0	0	0
6	0.912	0.912	0.912	0.912	0	0	0
7	0.910	0.910	0.910	0.910	0	0	0
8	0.880	0.880	0.880	0.880	0	0	0
9	0.911	0.911	0.911	0.911	0	0	0
10	0.971	0.971	0.971	0.971	0.971	0	0
11	0	0.981	0.981	0.981	0.981	0	0
12	0	1.023	1.023	1.023	1.023	0	0
13	0	1.025	1.025	1.025	1.025	1.013	0
14	0	0	1.059	1.059	1.059	1.058	0
15	0	0	1.058	1.058	1.058	1.055	0
16	0	0	1.076	1.076	1.076	1.067	0
17	0	0	1.073	1.073	1.073	1.065	0
18	0	0	1.064	1.064	1.064	1.064	0
19	0	0	1.093	1.093	1.093	1.091	0
20	0	0	0.582	0.582	0.582	0.578	0
21	0	0	0	0.776	0.776	0.775	0
22	0	0	0	0.871	0.871	0.867	0
23	0	0	0	0.952	0.952	0.944	0
24	0	0	0	0.886	0.866	0.883	0
25	0	0	0	0	1.032	1.035	0
26	0	0	0	0	0.865	0.859	0
27	0	0	0	0	0.860	0.862	0
28	0	0	0	0	0	0.948	0
29	0	0	0	0	0	0.769	0
30	0	0	0	0	0	0.291	0

Table D-2. Continuation Rates by Grade and Year of Service for MOS 11C

Year of Service	Grade E1-E3	E4	E5	E6	E7	E8	E9
1	0.848	0.848	0.848	0	0	0	0
2	0.776	0.776	0.776	0	0	0	0
3	0.682	0.682	0.682	0	0	0	0
4	0.722	0.722	0.722	0	0	0	0
5	0.916	0.916	0.916	0	0	0	0
6	0.903	0.903	0.903	0.903	0	0	0
7	0.896	0.896	0.896	0.896	0	0	0
8	0.895	0.895	0.895	0.895	0	0	0
9	0.875	0.875	0.875	0.875	0	0	0
10	0.879	0.879	0.879	0.879	0.879	0	0
11	0	0.946	0.946	0.946	0.946	0	0
12	0	1.015	1.015	1.015	1.015	0	0
13	0	0.951	0.951	0.951	0.951	0	0
14	0	0	1.050	1.050	1.050	0	0
15	0	0	1.038	1.038	1.038	0	0
16	0	0	1.020	1.020	1.020	0	0
17	0	0	1.026	1.026	1.026	0	0
18	0	0	1.060	1.060	1.060	0	0
19	0	0	1.078	1.078	1.078	0	0
20	0	0	0.560	0.560	0.560	0	0
21	0	0	0	0.770	0.770	0	0
22	0	0	0	0.850	0.850	0	0
23	0	0	0	0.904	0.904	0	0
24	0	0	0	0.864	0.864	0	0
25	0	0	0	0	1.054	0	0
26	0	0	0	0	0.828	0	0
27	0	0	0	0	0.874	0	0
28	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0

Table D-3. Continuation Rates by Grade and Year of Service for MOS 11D

Year of Service	Grade E1-E3	E4	E5	E6	E7	E8	E9
1	0.848	0.848	0.848	0	0	0	0
2	0.774	0.774	0.744	0	0	0	0
3	0.899	0.899	0.899	0	0	0	0
4	0.862	0.862	0.862	0	0	0	0
5	0.966	0.966	0.966	0	0	0	0
6	1.019	1.019	1.019	1.019	0	0	0
7	0.975	0.975	0.975	0.975	0	0	0
8	0.969	0.969	0.969	0.969	0	0	0
9	1.035	1.035	1.035	1.035	0	0	0
10	1.098	1.098	1.098	1.098	1.098	0	0
11	0	1.114	1.114	1.114	1.114	0	0
12	0	1.039	1.039	1.039	1.039	0	0
13	0	0.985	0.985	0.985	0.985	0.985	0
14	0	0	1.008	1.008	1.008	1.008	0
15	0	0	1.048	1.048	1.048	1.048	0
16	0	0	1.083	1.083	1.083	1.083	0
17	0	0	1.093	1.093	1.093	1.093	0
18	0	0	1.020	1.020	1.020	1.020	0
19	0	0	1.064	1.064	1.064	1.064	0
20	0	0	0.616	0.616	0.616	0.616	0
21	0	0	0	0.694	0.694	0.694	0
22	0	0	0	0.827	0.827	0.827	0
23	0	0	0	0.914	0.914	0.914	0
24	0	0	0	0.873	0.873	0.873	0
25	0	0	0	0	0.953	0.953	0
26	0	0	0	0	0.817	0.817	0
27	0	0	0	0	0.874	0.874	0
28	0	0	0	0	0	1.005	0
29	0	0	0	0	0	0.804	0
30	0	0	0	0	0	0.388	0

Table D-4. Continuation Rates by Grade and Year of Service for MOS 11E

Year of Service	E1-E3	E4	E5	E6	E7	E8	E9
1	0.848	0.848	0.848	0	0	0	0
2	0.777	0.777	0.777	0	0	0	0
3	0.709	0.709	0.709	0	0	0	0
4	0.797	0.797	0.797	0	0	0	0
5	0.975	0.975	0.975	0	0	0	0
6	0.998	0.998	0.998	0.998	0	0	0
7	1.049	1.049	1.047	1.049	0	0	0
8	0.998	0.998	0.998	0.998	0	0	0
9	1.114	1.114	1.114	1.114	0	0	0
10	1.162	1.162	1.162	1.162	1.162	0	0
11	0	1.168	1.168	1.168	1.168	0	0
12	0	1.236	1.236	1.236	1.236	0	0
13	0	1.186	1.186	1.186	1.186	1.120	0
14	0	0	1.144	1.144	1.144	1.099	0
15	0	0	1.228	1.228	1.228	1.169	0
16	0	0	1.168	1.168	1.168	1.140	0
17	0	0	1.055	1.055	1.055	1.068	0
18	0	0	1.085	1.085	1.085	1.063	0
19	0	0	1.077	1.077	1.077	1.073	0
20	0	0	0.569	0.569	0.569	0.584	0
21	0	0	0	0.763	0.763	0.722	0
22	0	0	0	0.864	0.864	0.852	0
23	0	0	0	0.880	0.880	0.891	0
24	0	0	0	0.799	0.799	0.824	0
25	0	0	0	0	0.978	0.870	0
26	0	0	0	0	0.768	0.784	0
27	0	0	0	0	0.906	0.896	0
28	0	0	0	0	0	1.007	0
29	0	0	0	0	0	0.813	0
30	0	0	0	0	0	0.279	0

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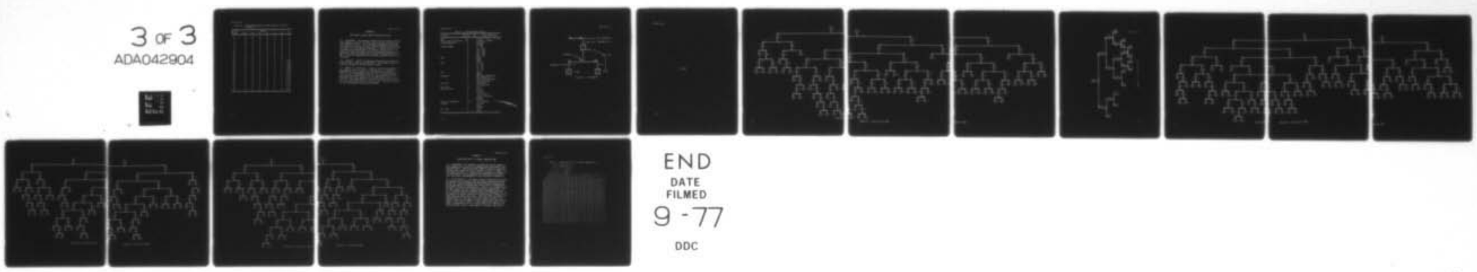

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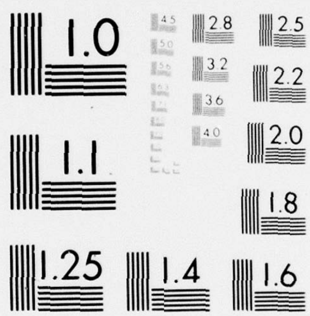


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table D-5. Continuation Rates by Grade and Year of Service for MOS 11Z

Year of Service	Grade E1-E3	E4	E5	E6	E7	E8	E9
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	1.070
15	0	0	0	0	0	0	1.088
16	0	0	0	0	0	0	1.088
17	0	0	0	0	0	0	1.066
18	0	0	0	0	0	0	1.064
19	0	0	0	0	0	0	1.085
20	0	0	0	0	0	0	0.580
21	0	0	0	0	0	0	0.760
22	0	0	0	0	0	0	0.863
23	0	0	0	0	0	0	0.929
24	0	0	0	0	0	0	0.865
25	0	0	0	0	0	0	1.016
26	0	0	0	0	0	0	0.838
27	0	0	0	0	0	0	0.872
28	0	0	0	0	0	0	0.965
29	0	0	0	0	0	0	0.782
30	0	0	0	0	0	0	0.287

APPENDIX E

AID RESULTS USED TO DERIVE RETENTION FACTORS

E-1. BACKGROUND. This appendix presents the AID results, derived from analysis of the FY 71 cohort, that were used to extract the four retention factors: race, education, dependents, pay grade. The significance and use of these retention factors are discussed in Chapter 4. As discussed in Chapter 4, a sample of 39,047 soldiers was extracted from the FY 71 cohort. The soldiers in this sample were then distributed among five subpopulations based on the SRB for which the soldier was eligible at separation/reenlistment. These five subpopulations were then analyzed using the AID III Model.

E-2. VARIABLES. Table E-1 shows the variables and the variable classes used as input to the AID Model. The variable classifications are defined in the "Definition" column.

E-3. EXAMPLE OF AID RESULTS. Figure E-1 provides an example of the symbology used in Figures E-1 through E-5. In Figure E-1, population #5 consisting of 3,036 black soldiers (variable Race, class 2) with a reenlistment rate of 0.252 is subdivided based on pay grade into populations #24 and 25; population #24 has 794 black soldiers in pay grades E1-E3 who have reenlisted at a rate of 0.049. Population #25 has 2,242 black soldiers in pay grades E4/E5 who have reenlisted at a rate of 0.324. Figures E-2 through E-6 are interpreted in the preceding manner.

Table E-1. AID Variables/Classes

Variable	Class	Class definition
Age	1-7	17-23 (1 = 17,..., 7 = 23)
Initial Term of Service	2-6	2 years - 6 years
Enlisted/Drafted	1	Enlistee
	2	Draftee
Lottery Number	1	1 - 50
	2	51 - 100
	3	101 - 150
	4	151 - 200
	5	201 - 250
	6	251 - 366
Race	1	White
	2	Black
	3	Other
AFQT	1	93 - 99
	2	65 - 92
	3	31 - 64
	4	16 - 30
	5	1 - 15
Sex	1	Male
	2	Female
Education	1	Non High School Grad
	2	High School Grad
	3	More than High School
	4	GED High School
Duty MOS	1	Combat MOS
	2	Non Combat MOS
Pay Grade	1-7	E1-E7
Marital Status	1	Single
	2	Married
	3	Divorced
	4	Interlocutory
	5	Legally Separated
	6	Widowed
	7	Annulled
Number of Dependents	0-9	0-9 dependents
Location	1	Overseas
	2	CONUS
	3	Unknown
Zip Code	0	Rural
	1	Urban

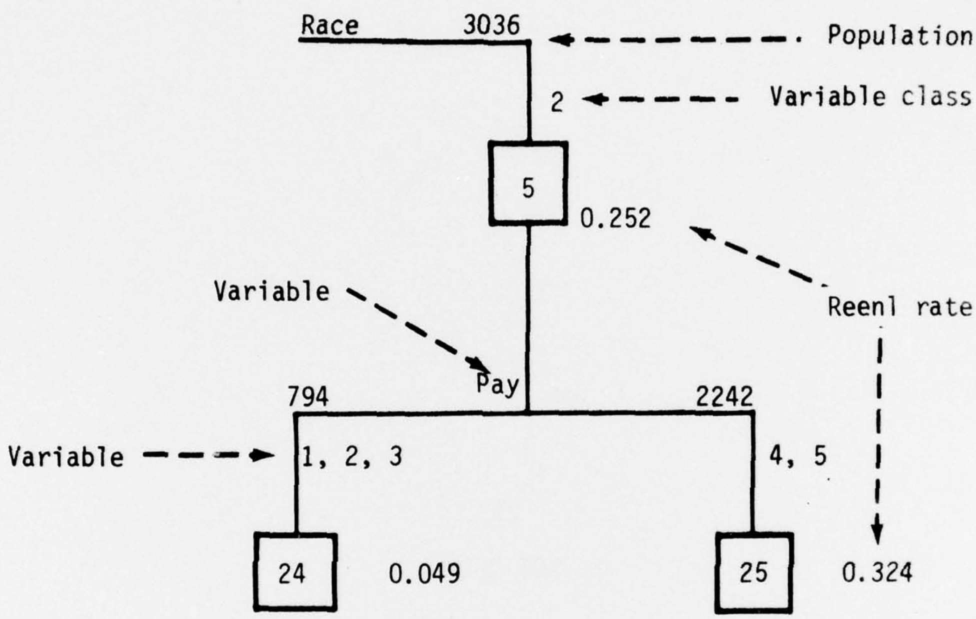


Figure E-1. AID Symbols

NOT USED

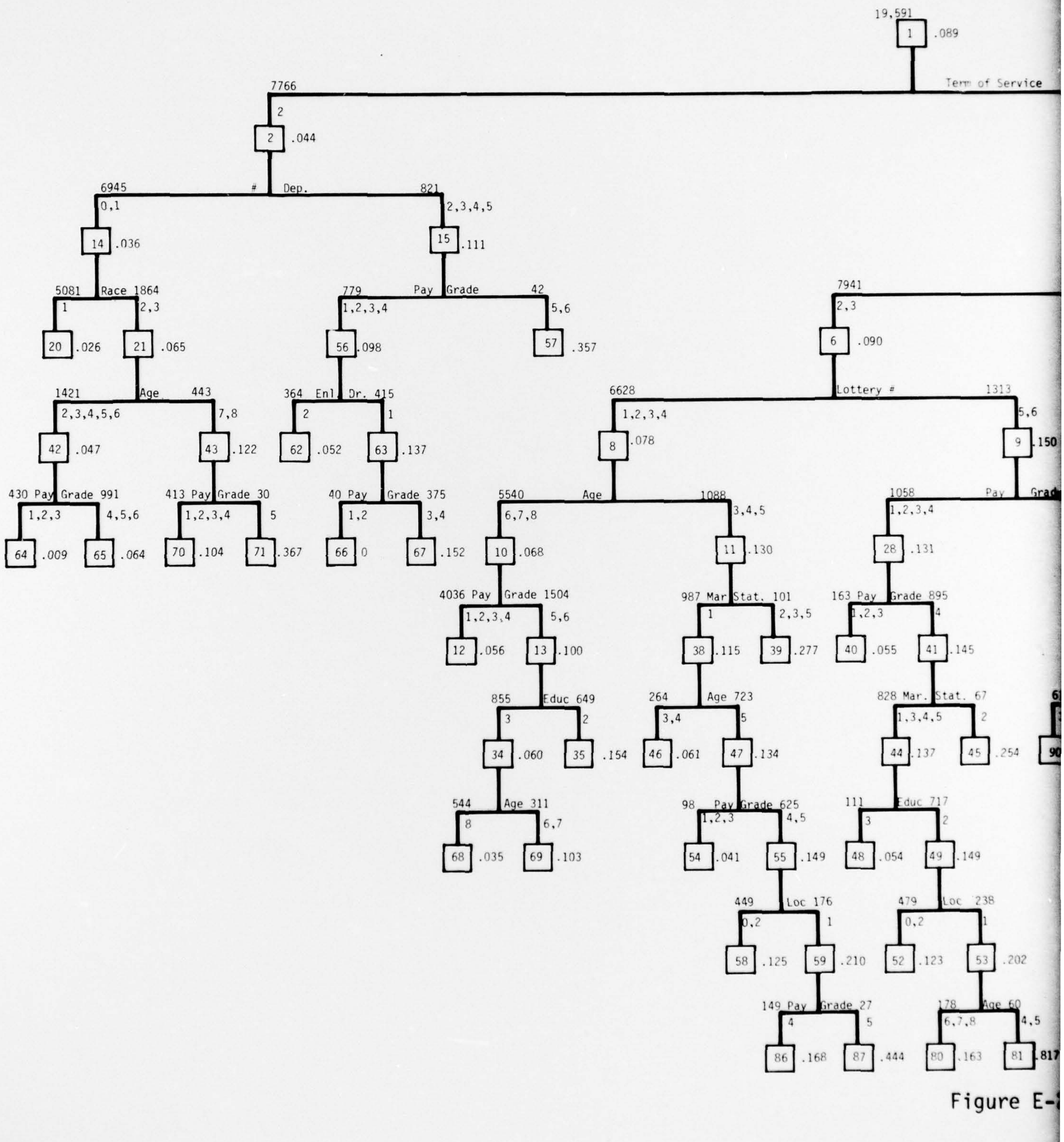

19,591
1 .089
Term of Service
7766
2
2 .044
6945 # Dep. 821
0,1
2,3,4,5
14 .036
15 .111
5081 Race 1864
1
2,3
20 .026
21 .065
1421 Age 443
2,3,4,5,6
7,8
42 .047
43 .122
430 Pay Grade 991
1,2,3
4,5,6
64 .009
65 .064
413 Pay Grade 30
1,2,3,4
5
70 .104
71 .367
779 Pay Grade 42
1,2,3,4
5,6
56 .098
57 .357
364 Enl. Dr. 415
2
1
62 .052
63 .137
40 Pay Grade 375
1,2
3,4
66 0
67 .152
7941
2,3
6 .090
6628 Lottery # 1313
1,2,3,4
5,6
8 .078
9 .150
5540 Age 1088
6,7,8
3,4,5
10 .068
11 .130
4036 Pay Grade 1504
1,2,3,4
5,6
12 .056
13 .100
855 Educ 649
3
2
34 .060
35 .154
544 Age 311
8
6,7
68 .035
69 .103
987 Mar Stat. 101
1
2,3,5
38 .115
39 .277
264 Age 723
3,4
5
46 .061
47 .134
98 Pay Grade 625
1,2,3
4,5
54 .041
55 .149
449 Loc 176
0,2
1
58 .125
59 .210
149 Pay Grade 27
4
5
86 .168
87 .444
1058 Pay Grade
1,2,3,4
28 .131
163 Pay Grade 895
1,2,3
4
40 .055
41 .145
828 Mar. Stat. 67
1,3,4,5
2
44 .137
45 .254
111 Educ 717
3
2
48 .054
49 .149
479 Loc 238
0,2
1
52 .123
53 .202
178 Age 60
6,7,8
4,5
80 .163
81 .817

Figure E-

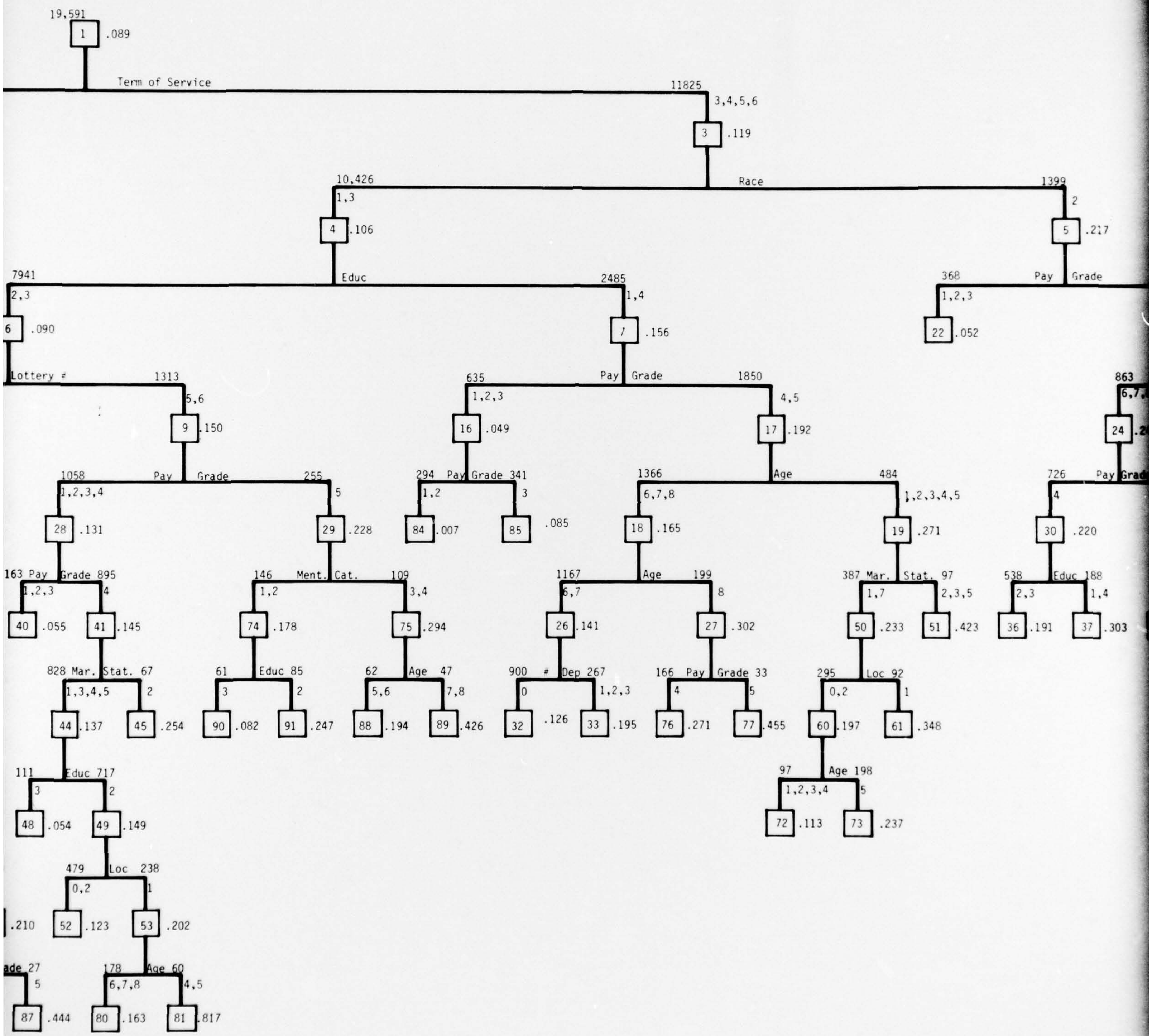
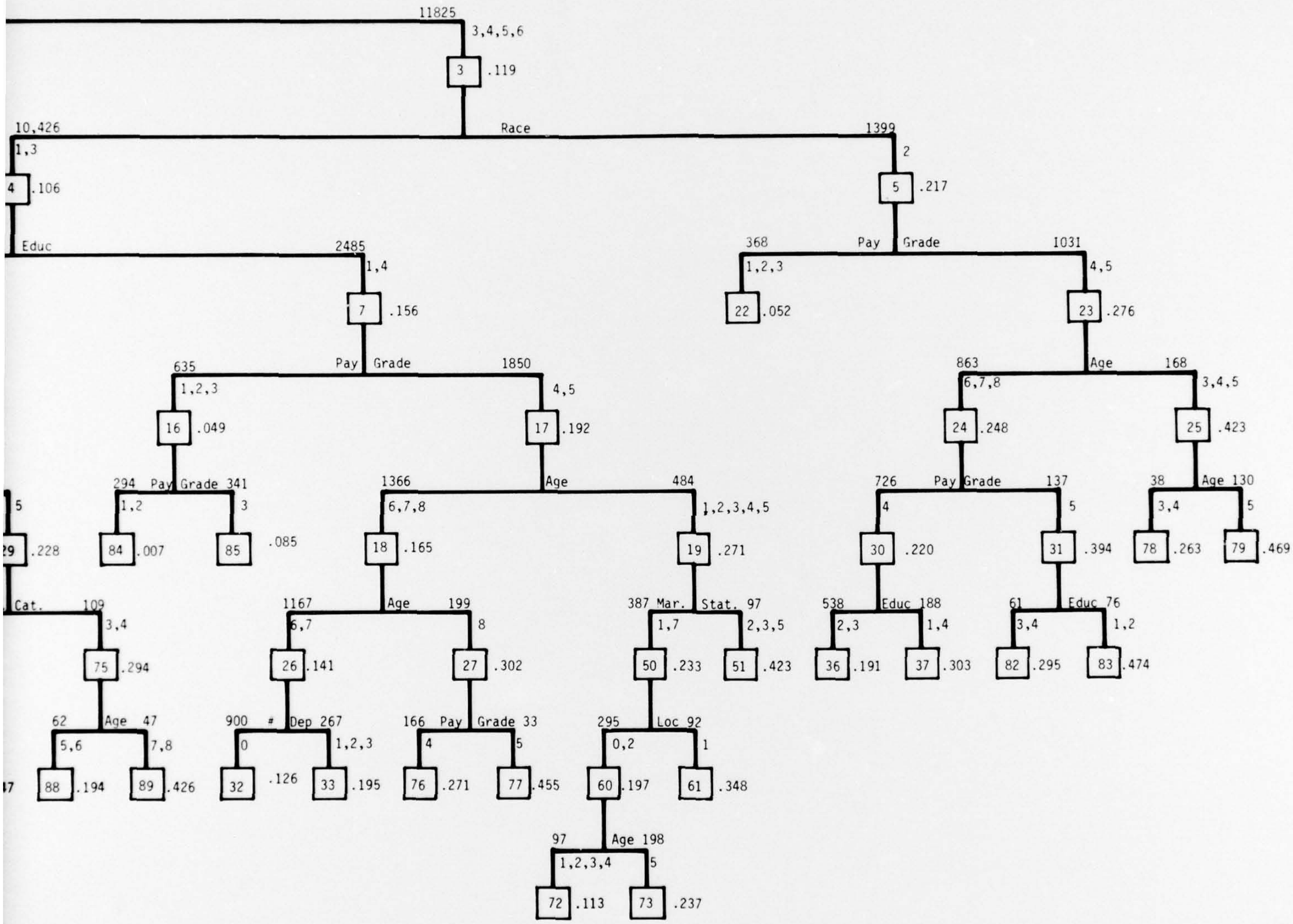


Figure E-2. AID Tree for SRB 1



ree for SRB 1

3

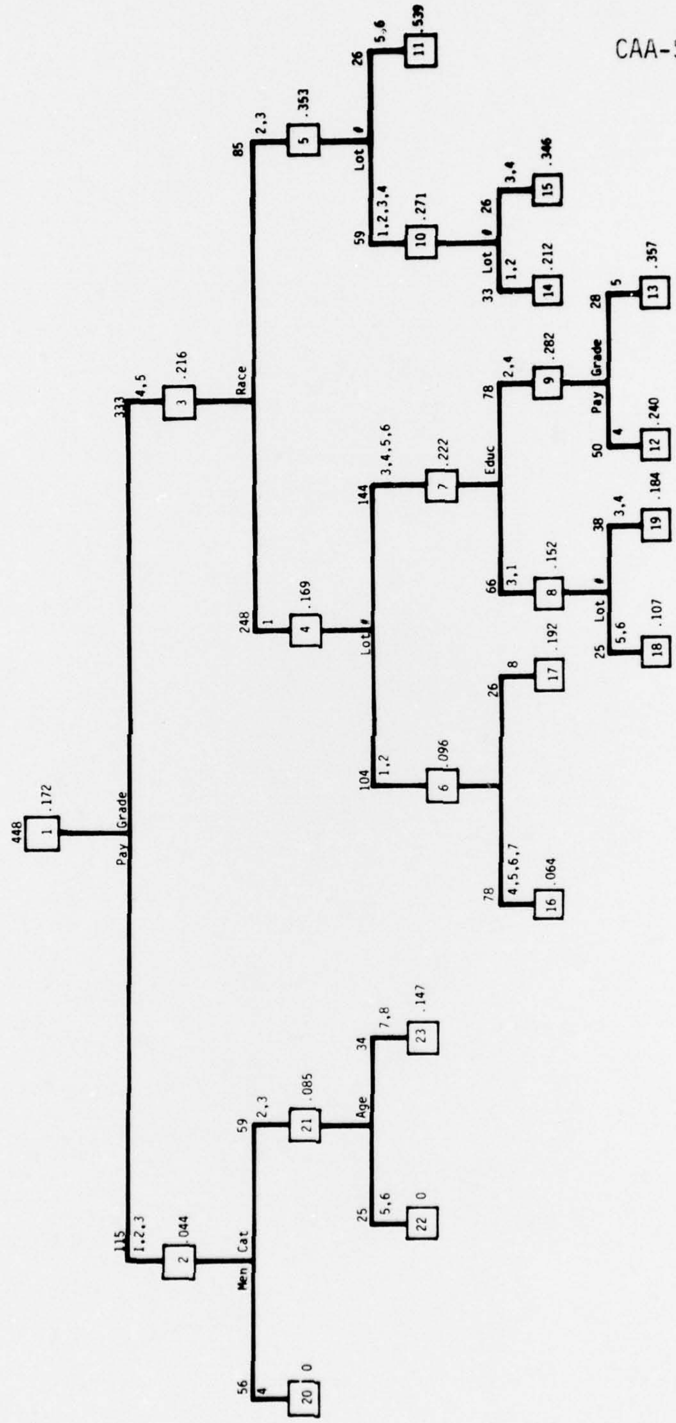


Figure E-3. AID Tree for SRB 2

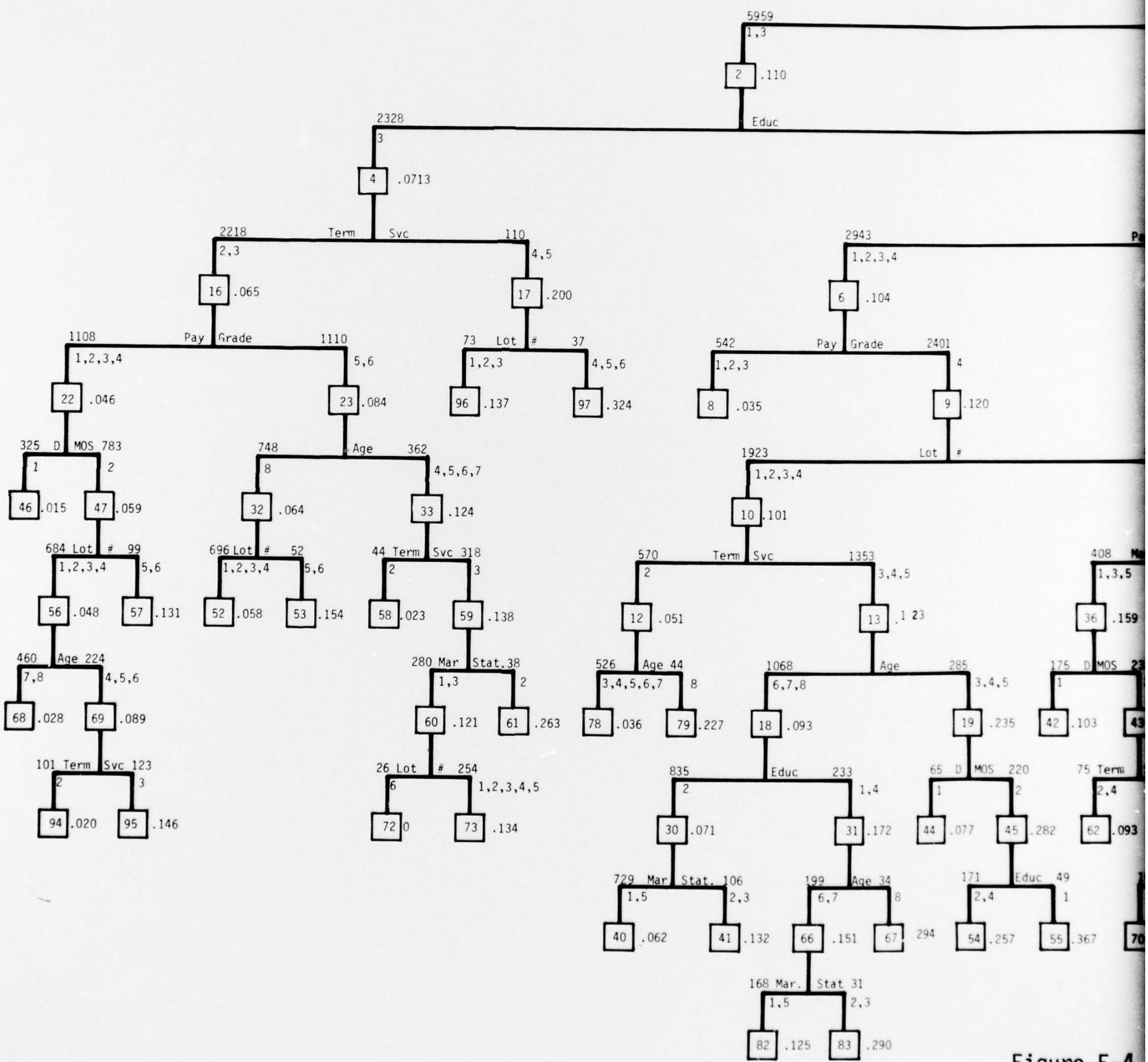

5959
1,3
2 .110
Educ
2328
3
4 .0713
Term Svc
2218
2,3
110
4,5
16 .065
17 .200
1108 Pay Grade 1110
1,2,3,4
5,6
22 .046
23 .084
73 Lot # 37
1,2,3
4,5,6
96 .137
97 .324
2943
1,2,3,4
6 .104
542 Pay Grade 2401
1,2,3
4
8 .035
9 .120
1923 Lot #
1,2,3,4
10 .101
570 Term Svc 1353
2
3,4,5
12 .051
13 .123
526 Age 44
3,4,5,6,7
8
78 .036
79 .227
1068 Age 285
6,7,8
3,4,5
18 .093
19 .235
835 Educ 233
2
1,4
30 .071
31 .172
729 Mar Stat. 106
1,5
2,3
40 .062
41 .132
199 Age 34
6,7
8
66 .151
67 .294
168 Mar. Stat 31
1,5
2,3
82 .125
83 .290
65 D MOS 220
1
2
44 .077
45 .282
171 Educ 49
2,4
1
54 .257
55 .367
408
1,3,5
36 .159
175 D MOS
1
42 .103
75 Term
2,4
62 .093
325 D MOS 783
1
2
46 .015
47 .059
684 Lot # 99
1,2,3,4
5,6
56 .048
57 .131
460 Age 224
7,8
4,5,6
68 .028
69 .089
101 Term Svc 123
2
3
94 .020
95 .146
748 Age 362
8
4,5,6,7
32 .064
33 .124
696 Lot # 52
1,2,3,4
5,6
52 .058
53 .154
44 Term Svc 318
2
3
58 .023
59 .138
280 Mar Stat. 38
1,3
2
60 .121
61 .263
26 Lot # 254
6
1,2,3,4,5
72 0
73 .134

Figure E-4.

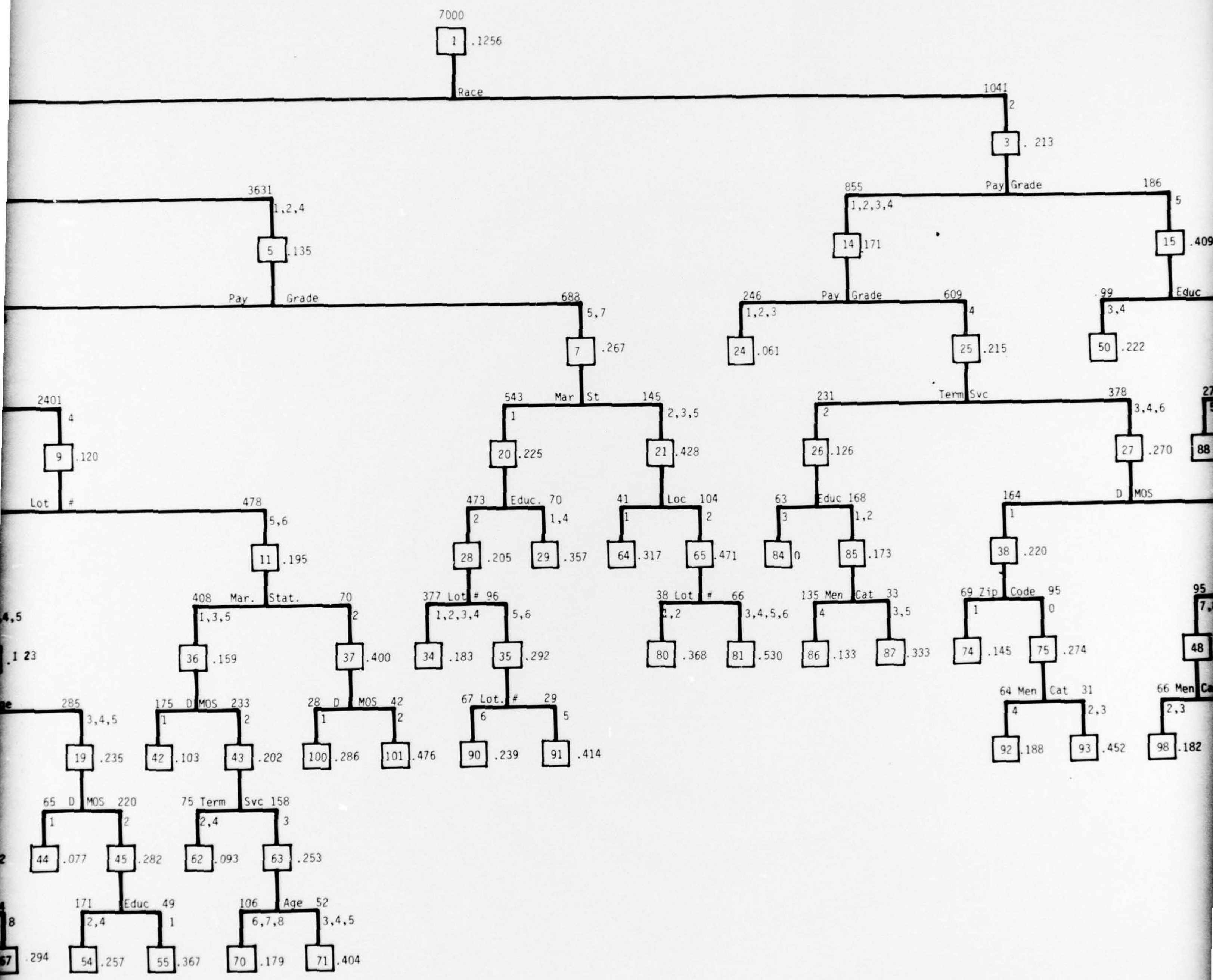
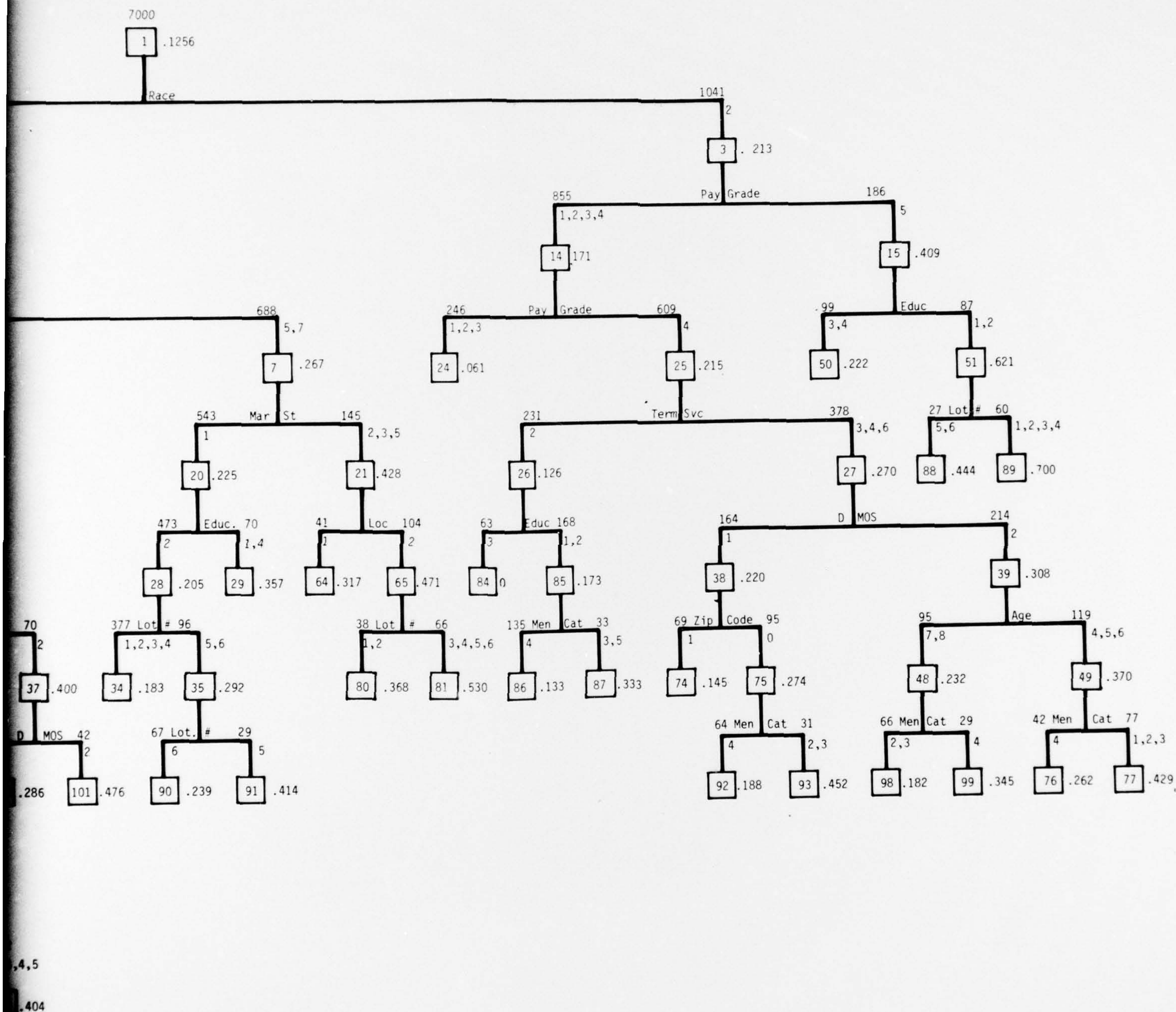


Figure E-4. AID Tree for SRB 3



ree for SRB 3

3

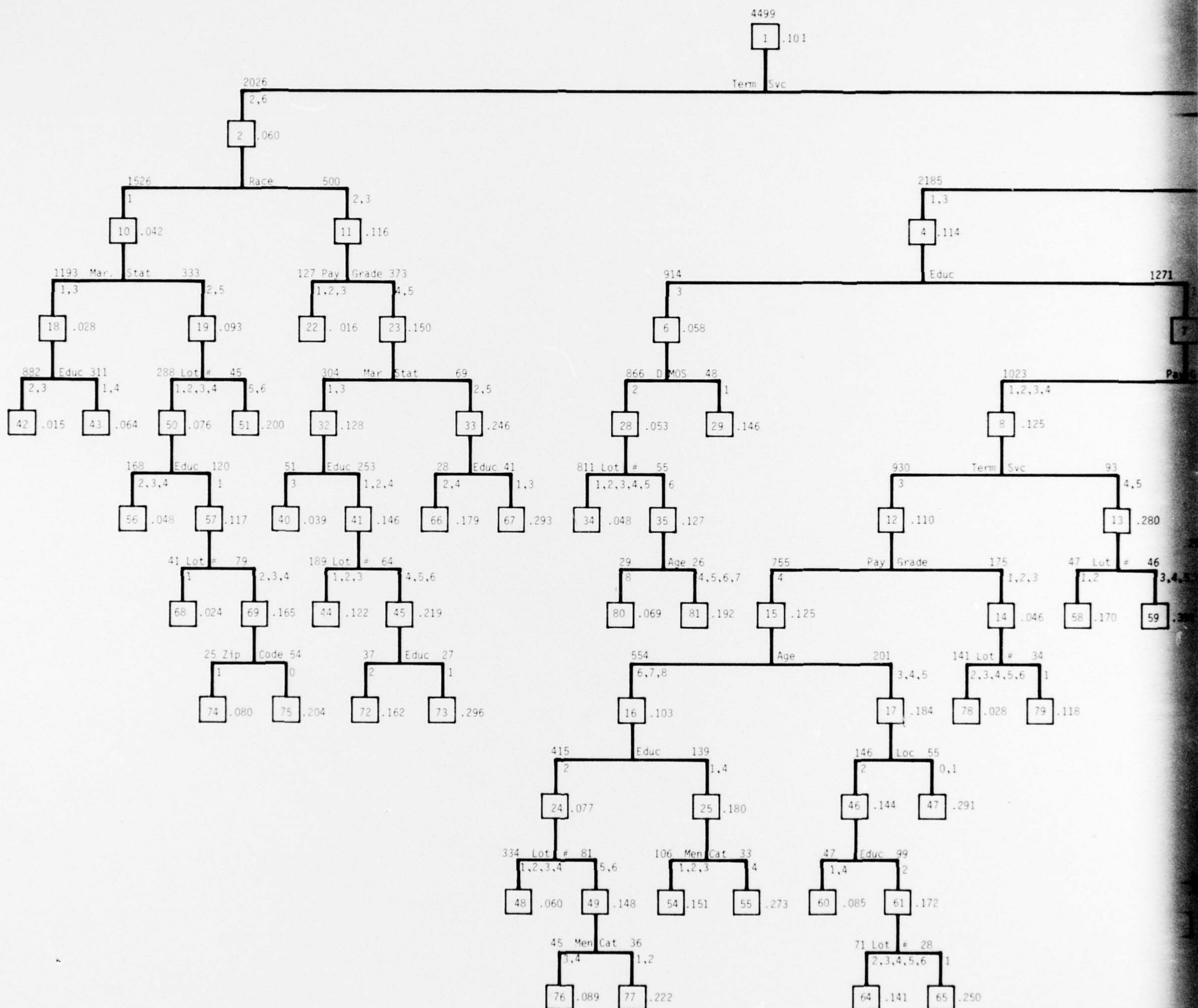


Figure E-5. AID Tree for SRB 4

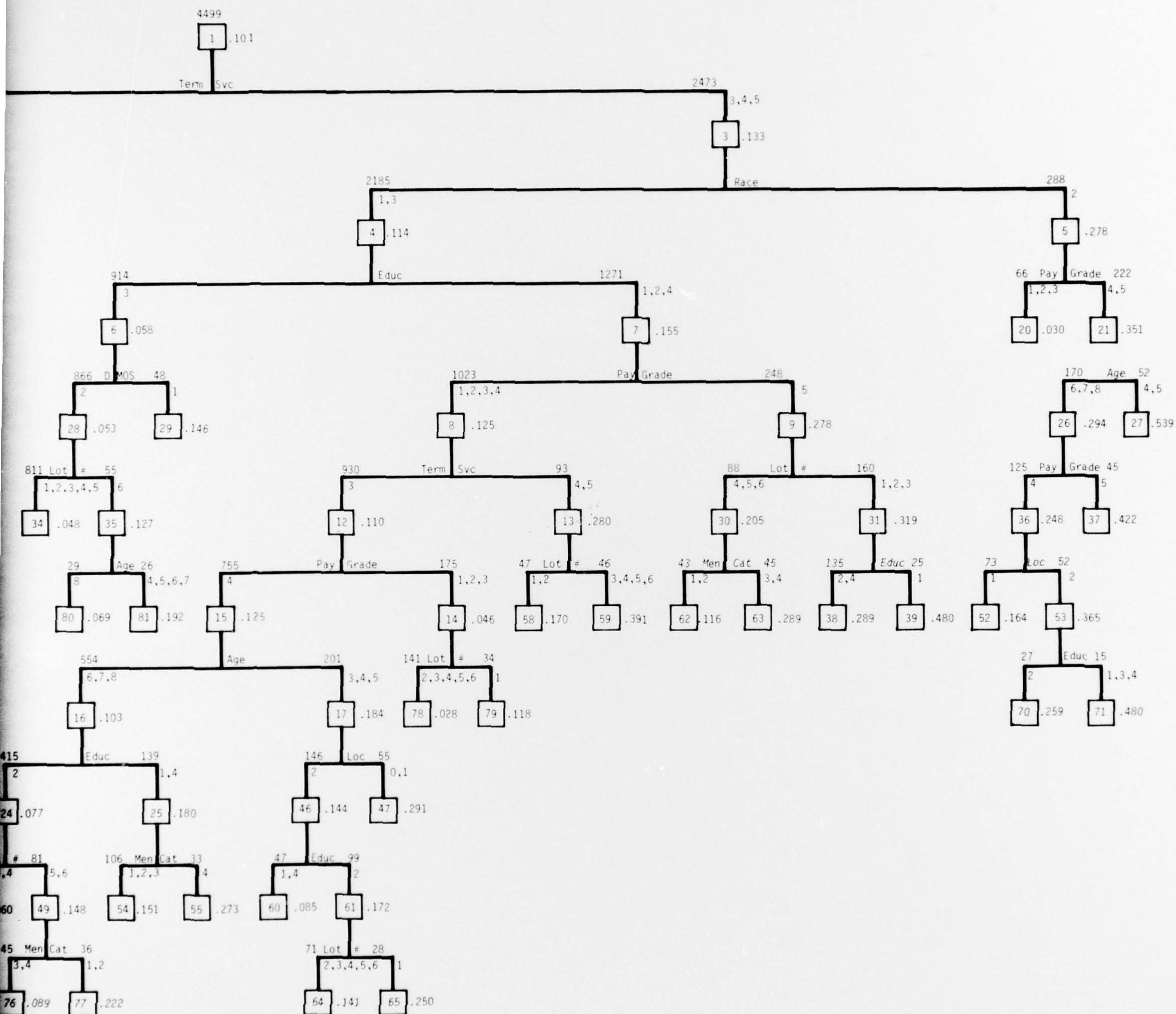


Figure E-5. AID Tree for SRB 4

2

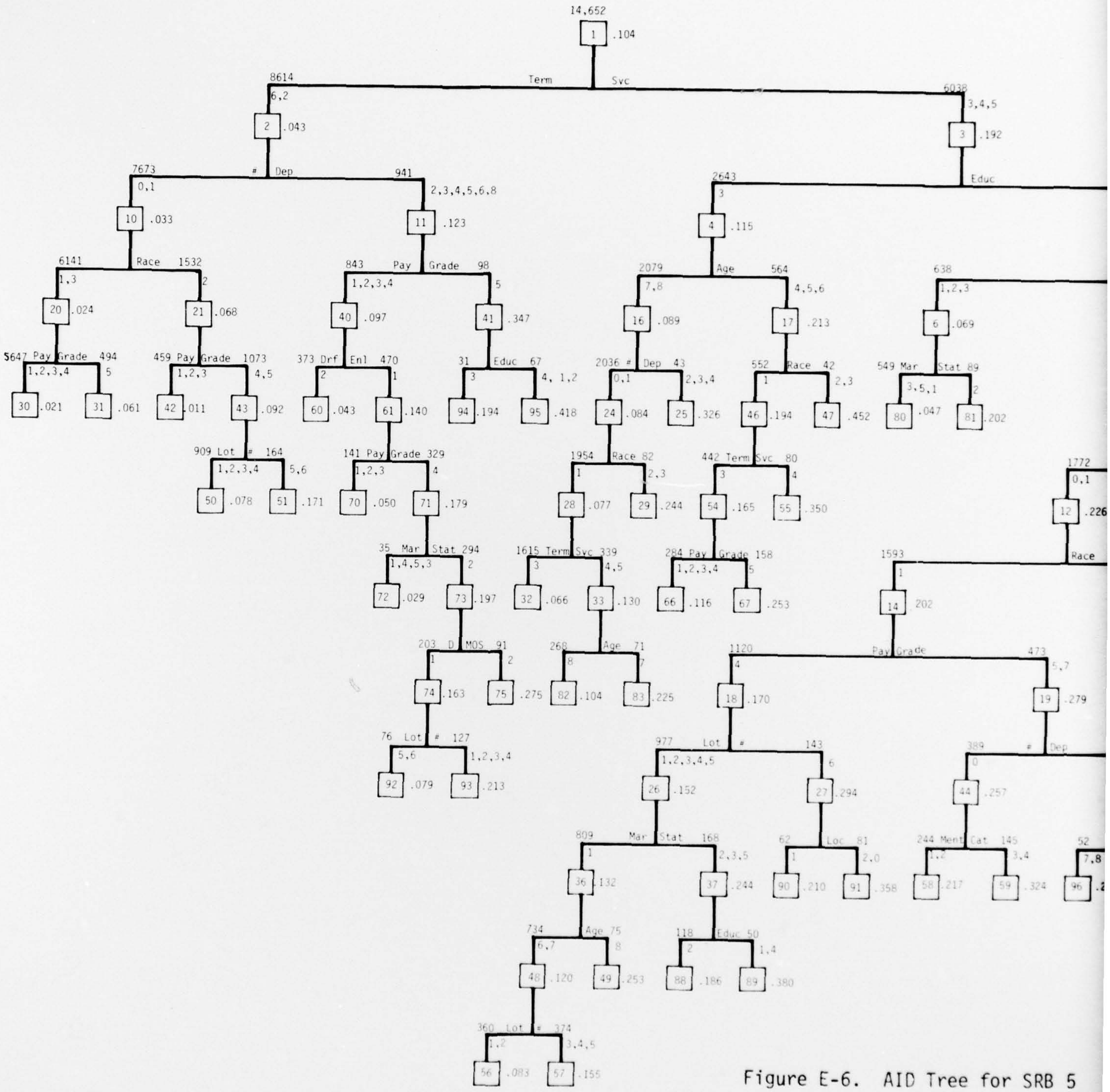


Figure E-6. AID Tree for SRB 5

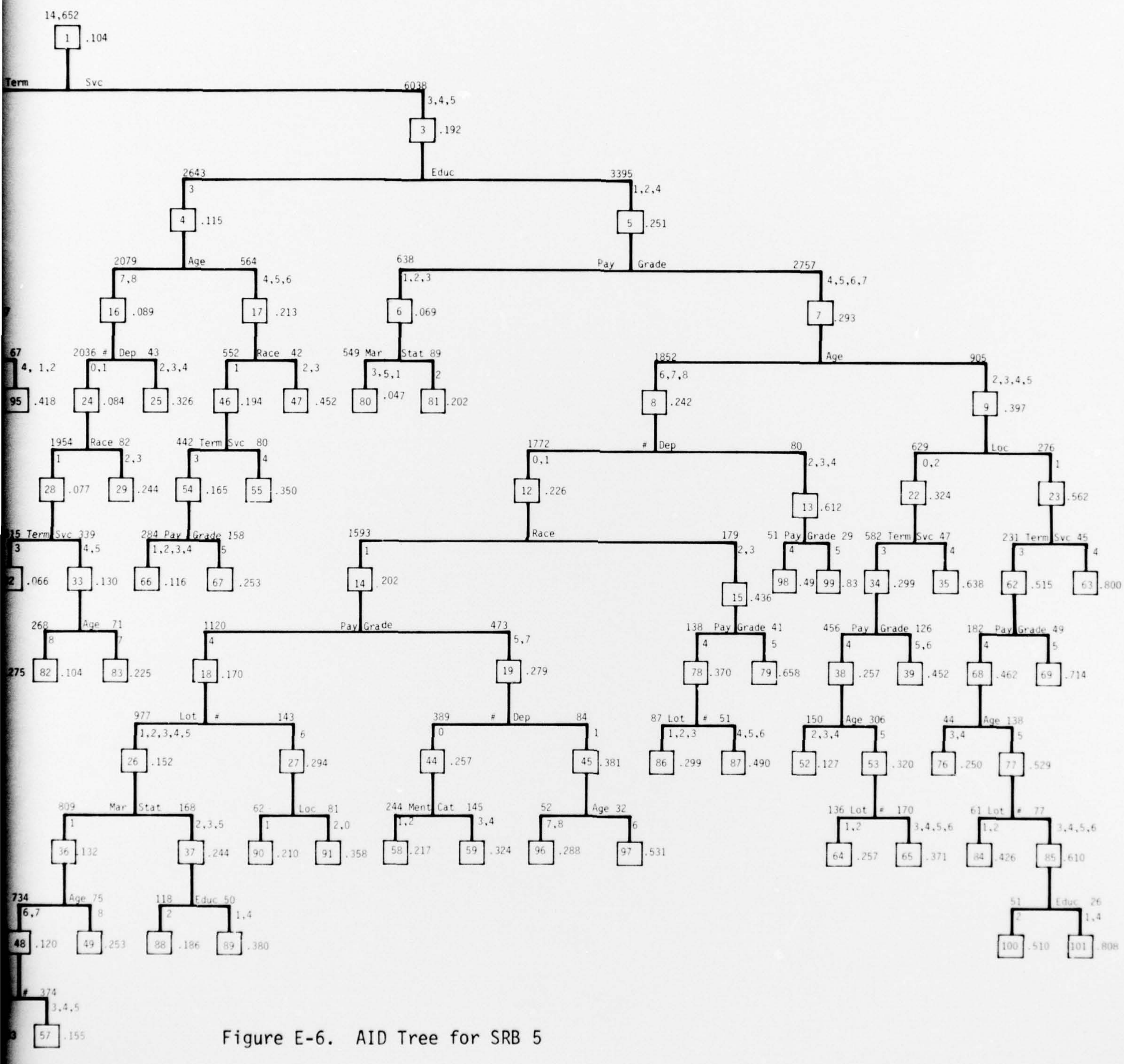


Figure E-6. AID Tree for SRB 5

APPENDIX F

COUNT DATA FOR FY 71 COHORT SUBPOPULATIONS

F-1. BACKGROUND. This Appendix provides the size and number of reenlistments within each of 32 subpopulations distributed across five SRB levels. These count data, shown in Table F-1, were developed from a sample of 39,047 soldiers in the FY 71 cohort file. This sample and the FY 71 cohort file are discussed in Chapter 4. The derivation of the 32 subpopulations defined by race, education, pay grade, and dependents is also discussed in Chapter 4.

F-2. USE OF TABLE F-1. The data in Table F-1 was used as a basis for developing reenlistment rates which permitted the assessment of the SRB. The effectiveness of the SRB was quantified by comparing the effect of different SRB levels within a subpopulation and between different subpopulations. Table F-1 is interpreted as follows: each row, 1-32, defines a specific subpopulation. Row 11, for example, defines a subpopulation comprised of soldiers with a GED high school equivalent, who have no dependents, who are pay grade E4 or above; and who are either white or a member of an ethnic minority other than black. The total number of soldiers in subpopulation "11" for each of five SRB levels is shown in the "total" column and the number of those soldiers who reenlisted is shown in the "re-up" column. In this example there were 161 soldiers in subpopulation "11" who, when eligible to reenlist, were offered an SRB 1; and, of this number, 39 soldiers reenlisted.

Table F-1. Count Data for FY 71 Cohort Subpopulations

	Subpopulations										Populations by SRB									
											SRB1		SRB2		SRB3		SRB4		SRB5	
	Non Highschool	Highschool Diploma	GED Highschool	More than Highschool	No Dependents	Dependents	Grades: E1-E3	Grades: E4 and above	Race: White and other	Race: Black	Total	Re-up	Total	Re-up	Total	Re-up	Total	Re-up	Total	Re-up
1	X				X		X		X		1449	27	27	1	157	4	197	6	315	3
2		X			X		X		X		1520	26	23	2	268	6	304	7	425	20
3			X		X		X		X		73	1	4	0	11	1	23	1	15	0
4				X	X		X		X		600	10	3	1	88	2	110	3	205	8
5	X					X	X		X		769	18	7	1	43	1	49	1	126	6
6		X				X	X		X		327	9	3	0	38	2	30	3	85	13
7			X			X	X		X		26	1	0	0	4	0	9	2	7	0
8				X		X	X		X		139	4	0	0	23	1	21	0	45	4
9	X				X			X	X		1714	254	61	14	191	42	417	76	403	109
10		X			X			X	X		5849	605	139	30	959	151	2032	300	2203	498
11			X		X			X	X		161	39	12	2	80	8	86	31	48	15
12				X	X			X	X		2771	147	47	2	969	57	1731	136	2389	225
13	X					X		X	X		887	133	12	1	77	11	118	33	159	49
14		X				X		X	X		947	140	22	8	167	25	291	81	357	122
15			X			X		X	X		278	19	2	1	23	1	34	9	54	11
16				X		X		X	X		702	35	13	2	230	12	533	45	609	83
17	X				X		X			X	165	6	30	0	30	0	57	3	90	6
18		X			X		X			X	234	13	11	0	50	1	82	6	73	4
19			X		X		X			X	13	1	0	0	2	0	5	0	2	0
20				X	X		X			X	38	3	2	0	8	0	9	1	10	0
21	X					X	X			X	22	1	2	0	4	0	9	1	11	0
22		X				X	X			X	23	0	1	0	8	1	14	0	16	0
23			X			X	X			X	2	0	0	0	0	0	1	0	0	0
24				X		X	X			X	12	1	0	0	5	0	2	0	6	0
25	X				X			X		X	213	67	28	6	29	12	82	18	58	28
26		X			X			X		X	638	170	48	21	125	45	340	136	226	105
27			X		X			X		X	27	9	1	0	3	2	19	8	9	5
28				X	X			X		X	210	54	5	1	55	14	146	44	87	26
29	X					X		X		X	30	9	2	0	5	3	12	5	8	2
30		X				X		X		X	83	22	5	3	19	6	40	20	32	19
31			X			X		X		X	2	2	1	0	2	1	1	0	1	0
32				X		X		X		X	36	4	1	0	12	3	20	5	32	11